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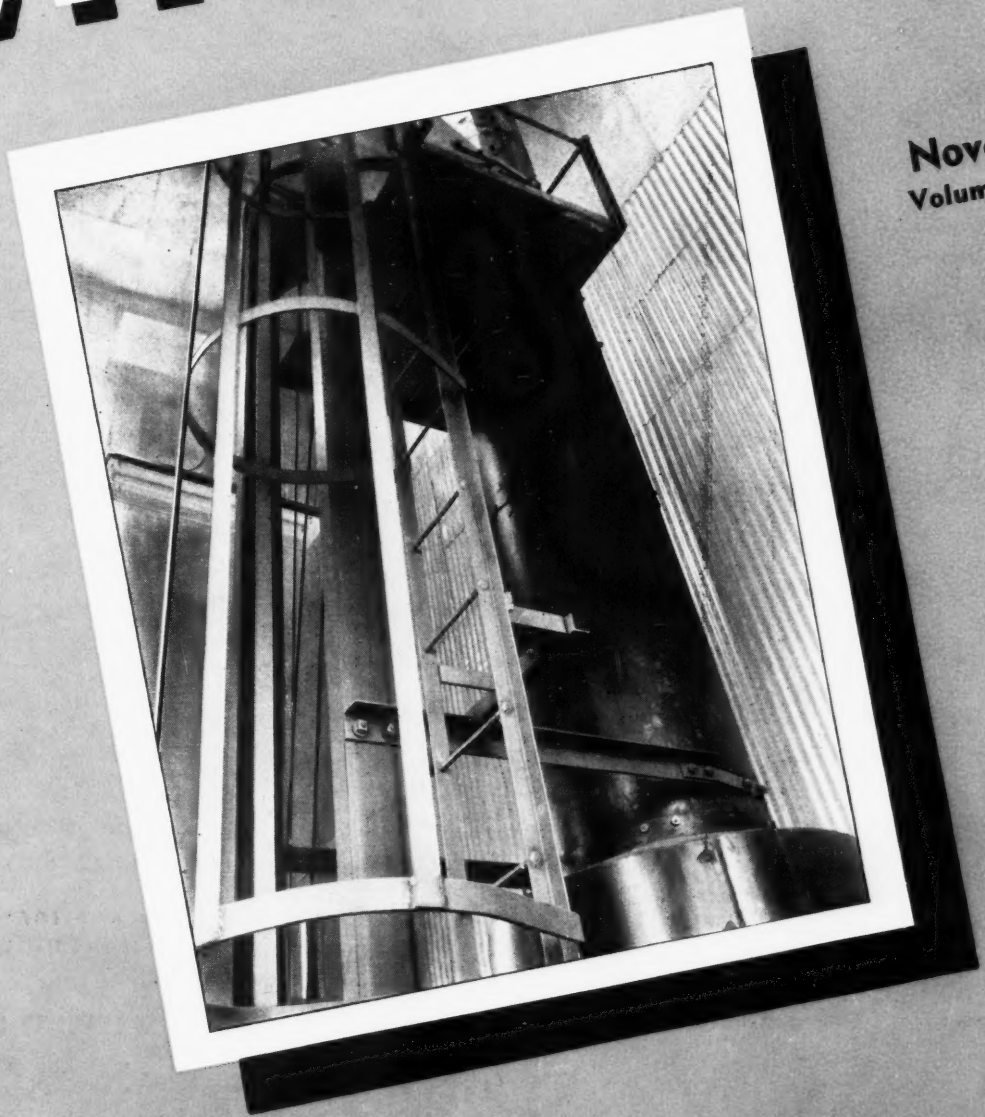

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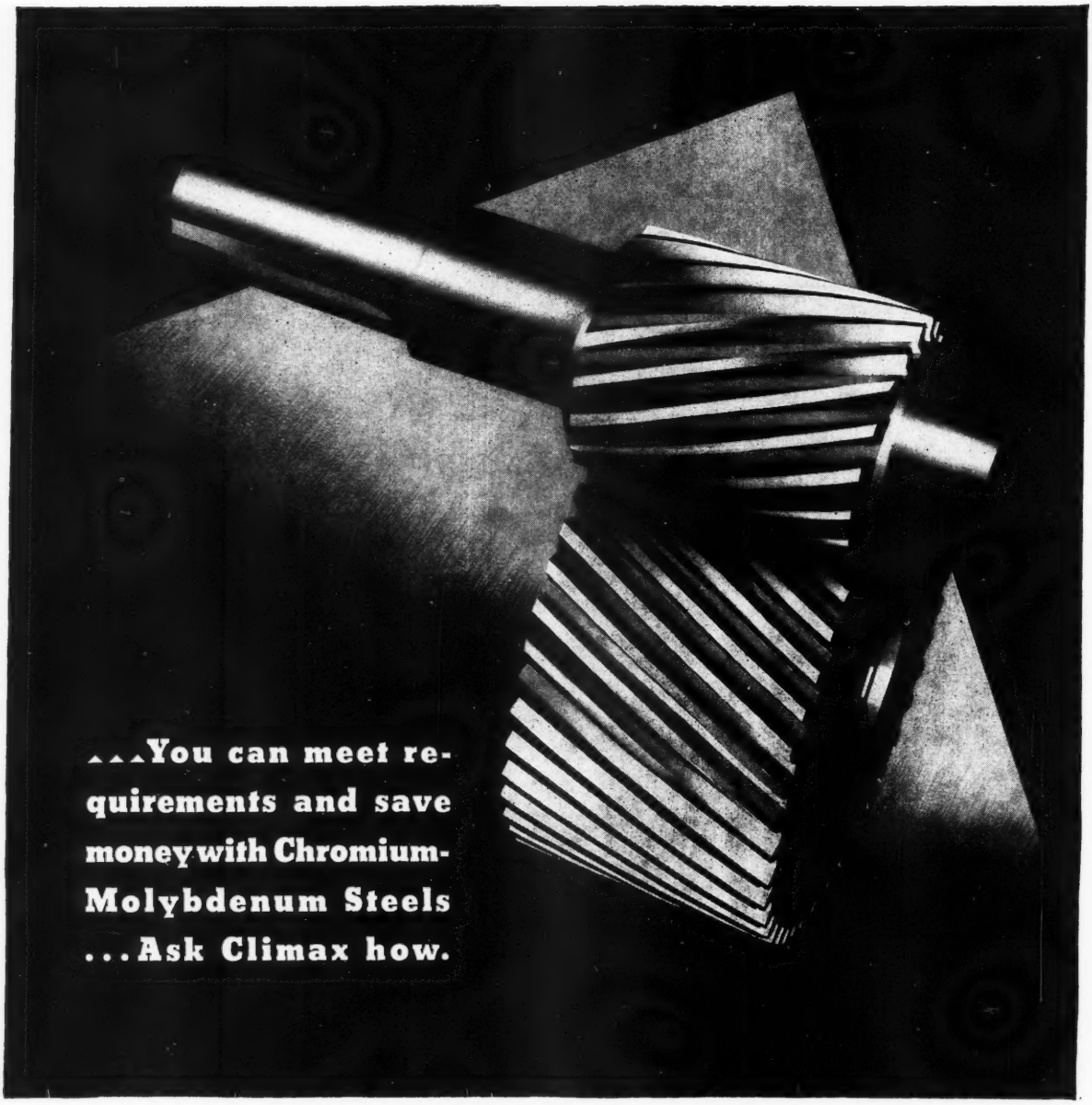

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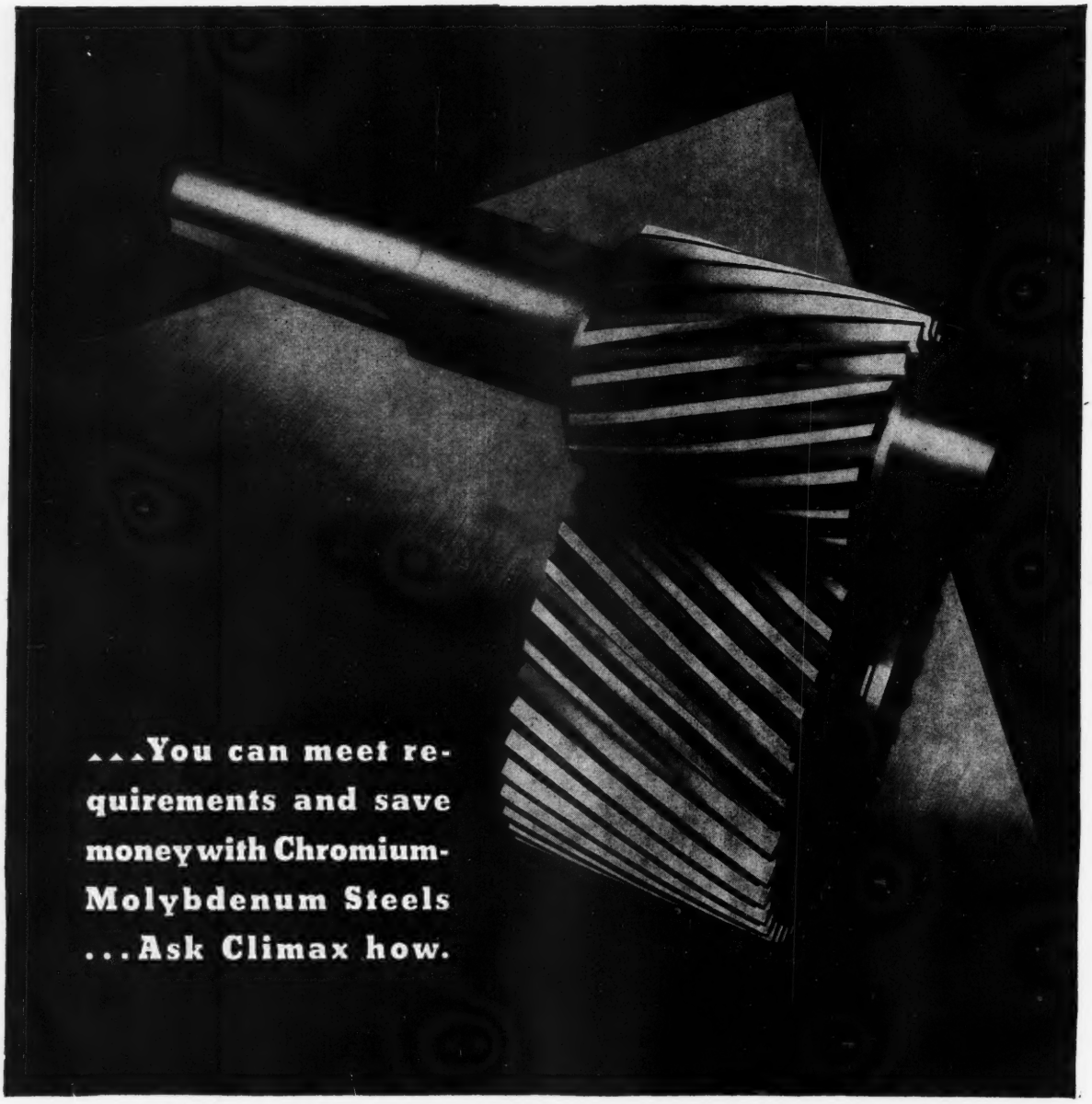

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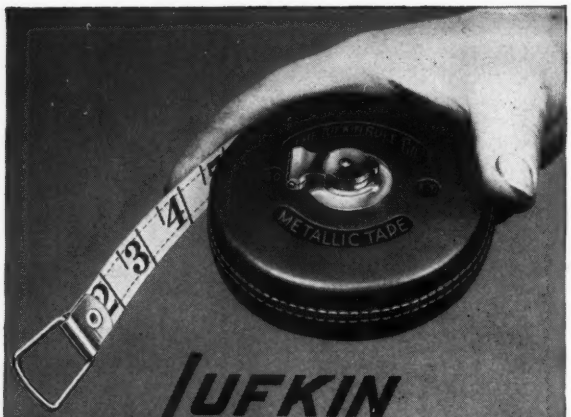

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—*Courtesy* E. B. BADGER & SONS' CO.

Houdry Unit In A Large Pennsylvania Refinery

Modern Catalytic Cracking

CHARLES C. WINDING

Associate Professor of Chemical Engineering

Recent developments in the refining of antiknock gasoline

Professor C. C. Winding

THE development of the internal combustion motor and the general use of motor vehicles has caused gasoline to become the principal product of the petroleum industry. It now comprises about one half of all the various products obtained from crude petroleum, although nowhere near this percentage of gasoline exists as such in the crude. If it were not for cracking and related processes which increase the yield of gasoline, we would have had to use nearly twice as much of our petroleum resources with almost complete depletion of our reserves. In addition, it would not have been possible to develop the modern high-performance motors. Cracked gasoline first appeared on the market in 1913 as an inferior motor fuel. At first offered at a reduced price to promote its use, it now comprises fifty per cent of all gasoline consumed.

The essential features of the early cracking processes were simple, although the engineering involved in their commercial development and operation was a major achievement considering the materials of construction then available. Thermal or pyrolytic cracking merely consists of subjecting a comparatively heavy petroleum fraction to elevated temperatures (900° to 1100°F.) at moderately high pressures (250 to 1000 lb. per sq. in.) for controlled periods of time with subsequent recovery of the products. These conditions cause a breakdown or "cracking" of the larger molecules present in the heavy fraction to form smaller molecules. Since gasoline and petroleum gases consist of comparatively small molecules, a large portion of gasoline and some gas is produced. At the same time competing and sometimes opposite reactions are taking place. Some of the cracked, or newly formed, molecules are extremely active and tend to combine or polymerize into much larger molecules. In addition, they frequently split off hydrogen. These latter reactions form progressively heavier fractions yielding heavy fuel oils, tars, and coke. Thus if a gas oil, averaging 16 carbon atoms to the molecule, is charged to the cracking coils, four products may result: gas, composed of 3-carbon molecules on the average; a gasoline fraction in the range of eight carbons; some of the original charging stock; and a heavy residue composed of molecules containing a hundred or more carbon atoms. Gasoline produced by thermal cracking has fair antiknock qualities and is better than the straight run gasoline obtained from the same crude. The various fractions produced by thermal cracking are important as many new developments depend on them.

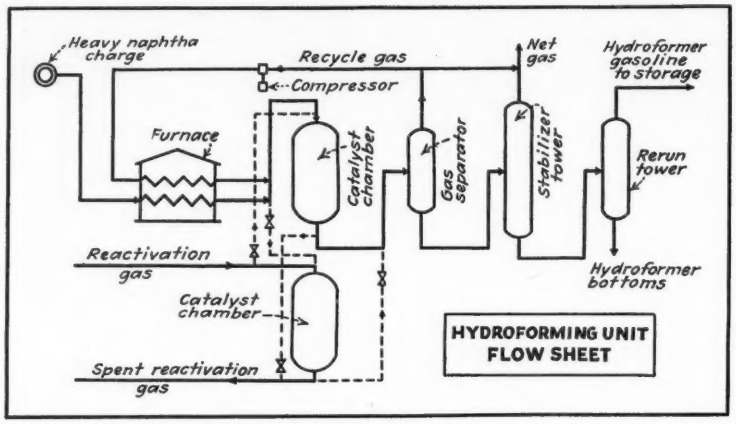
PROFESSOR C. C. Winding was graduated from the University of Minnesota in 1931 with a B. Chem. E. degree. He remained at Minnesota and after four years of research received his Ph.D. In the fall of 1935 he came to Cornell as an instructor; he was promoted to assistant professor in 1938 and was advanced to associate professor this fall.

He is a member of Tau Beta Pi, Sigma Xi, Phi Kappa Phi, AIChemE, and the American Chemical Society.

The thermal cracking process produced more gasoline better suited to modern motors, but compression ratios continued to mount and horsepower per unit weight and size was continually increased. At first this demand for higher antiknock fuels was met by the general use of ethyl fluid. There is, however, an economical and practical limit to the amount of ethyl fluid that can be included in motor fuels. Within the last few years the demand for higher octane fuels has been met by many new processes. Catalytic cracking, polymerization, polyforming, alkylation, and hydroforming are new processes and terms that have become familiar to the petroleum engineer in the effort to produce fuels to meet the demands of today and tomorrow.

Catalytic Cracking

Catalytic cracking became commercially important with the operation of the first large-scale Houdry plant in 1938. Since that time fifteen additional units have been built. In this process a suitable charging stock is vaporized, the heavy ends or tar removed, and the hot vapors passed through a bed of solid catalyst which promotes the cracking reaction. The aluminosilicate catalyst permits the use of milder conditions. Pressures of 40 to 60 lb. per sq. in. and tempera-



—*Courtesy* CHEMICAL AND METALLURGICAL ENGINEERING

tures of 800° to 900°F are used. The catalyst tends to control and direct the cracking reaction in a manner that produces a high quality gasoline fraction. As the reaction proceeds, carbon or coke is deposited on the surface of the catalyst particles, eventually blanketing them so that their activity is decreased beyond economical limits. When this point is reached, it is necessary to regenerate the catalyst. The oil vapors are shut off; vacuum is applied to purge the system of oil vapors; preheated air is admitted to burn off the deposited carbon; vacuum is again used for purging; and finally the oil vapors are re-admitted to the regenerated catalyst. To carry out this intermittent process, the catalyst is enclosed in several "cases" 38 feet high and 12 feet in diameter, which are operated on a staggered cycle to permit continuous operation of the plant. The actual cycle is short; 10 minutes on stream, 5 minutes purge, 10 minutes to regenerate, and a 5-minute purge. Since the purge and regeneration periods are non-productive, they have been made as short as possible.

Temperature control in the cases is extremely important. Heat must be supplied to maintain a temperature of 850°F during cracking, while temperatures during regeneration must not exceed 950°F. These two extremes may be reached within 10 minutes of each other. Both heating and cooling are necessary to prevent wider temperature fluctuations. To add to the difficulty, it is the temperature of a bed of granular solids that must be controlled. Good heat transfer is obtained by filling the cases about half full of tubes through which is circulated a molten salt composed of 40% sodium nitrite, 7% sodium nitrate and 50% potassium nitrate. This salt melts at 300°F, yet does not decompose appreciably at 1100°F. Cooling of the salt is accomplished in exchangers which produce 450-lb. steam for the unit.

The waste gases from the regeneration of the catalyst contain a considerable proportion of carbon monoxide which is converted to the dioxide by passing it over another catalyst bed. These gases then exhaust through a turbine coupled to both an air compressor and a generator. Enough power is obtained to compress all the air required and to furnish most of the electricity for the plant.

The Houdry process produces a gasoline of high antiknock qualities and good blending value. With suitable charging stocks it is capable of producing fractions which can be used as aviation stock or blended with straight run gasoline to produce regular fuel requiring no addition of ethyl fluid. One company is marketing such a gasoline. The process was developed by the Houdry interests together with the Sun Oil Company, the Socony-Vacuum Company, and E. B. Badger and Sons.

Another catalytic cracking process employing a moving catalyst principle is nearly ready for commercial operation. The use of a finely divided catalyst which flows through various units in a cycle similar to the Houdry makes it a continuous process. At the present time plants are being contructed by Standard Oil of New Jersey, Standard Oil of Indiana, and their subsidiaries. In this process the finely divided solid catalyst is injected into the stream of oil vapors, kept in contact with them for a given period of time, and then separated from the reaction products by centrifugal force in a separator of the "cyclone" type. From this point it passes through a regenerating system and then back into the process. Many advantages are claimed for this method of operation, the most important being the fact that it is continuous and does not have the disadvantages of intermittent operation. Very little information is at present available regarding details. As this process is just coming into large scale operation, it is not possible to state just how it will operate. Since it is a catalytic cracking process, a high yield of good quality antiknock gasoline is obtained.

These catalytic cracking processes have given us a means of obtaining gasoline blends that meet the increasing demands for high antiknock fuels, and at the same time increased the yield of gasoline per barrel of charging stock. In addition, the product requires less processing than that from thermal cracking to produce a finished fuel. They are assuming an important place in modern refining.

Polymerization Processes

All cracking processes produce considerable quantities of gas that used to be fed into the fuel gas system of the refinery. Refinery gases form only a portion of the available hydrocarbon gases in the United States. Tremendous quantities of natural gas are produced, more than can be conveniently used for fuel in many locations. It should be remembered that in the cracking process, part of the reaction was a polymerization which produced larger, heavier molecules than were present in the charging stock. Since the molecules in the gaseous fractions are too small, they would produce a gasoline fraction if they could be caused to unite or polymerize to larger molecules. This is essentially what occurs in all polymerization processes. Not all hydrocarbon gaseous compounds can be polymerized, but there is a

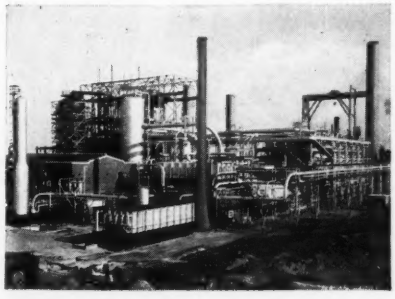
tremendous quantity of petroleum gas available—approximately 270,000 tons per day in this country, 44,000 tons of which could be utilized directly in polymerization processes. If this single day's production were converted quantitatively into gasoline, it would be enough to supply the peacetime requirements of all of Europe for a period of six months.

As in the cracking process, polymerization is accomplished both thermally and catalytically. The thermal method is operated much like the thermal cracking process except that temperatures up to 1100°F and pressures up to 3000 lb. are used. Gases containing three or four carbon atoms are converted to gasoline and heavier fractions. In this case the higher pressures tend to promote the polymerization reaction. Polymerization yields a high antiknock gasoline suitable for blending with other fractions to produce aviation fuels. The process is called "polyforming" when the gaseous stream is mixed with a light cracking stock such as a heavy naphtha. This modification permits not only the recovery of gases but also converts various naptha fractions into high grade gasolines at the same time. Both the Phillips Petroleum Company and the Gulf Oil Corporation are operating the polyforming process extensively.

The two well-known catalytic polymerization processes are those of the Universal Oil Products and of the Polyco. The two differ chiefly in the catalyst employed. The U.O.P. process uses ortho-phosphoric acid on a solid carrier, while the Polyco catalyst is copper pyrophosphate. Because of the catalyst much milder conditions are used.

Houdry Unit in New York refinery

—*Courtesy* E. B. BADGER & SONS' CO.



Temperatures are in the range of 250 to 400°F and pressures are below 1000 lb. per sq. in. Very small catalytic polymerization plants can be operated economically and are frequently found in small refineries. Only the unsaturated gases are polymerized by the catalytic processes so that yield of gasoline depends on the quantities of these gases present in the feed. The gasoline produced is of premium grade and much of it finds its way into aviation fuel.

Alkylation

Alkylation is a modified type of polymerization using a special feed to produce high antiknock blending stocks for aviation gasoline. In the high-pressure (4500 lb. per sq. in.) thermal process, neohexane (2,2 dimethylbutane) is produced from ethylene and isobutane. The catalytic process uses sulfuric acid as a catalyst to make iso-octane from butylene and isobutane. These two products have octane numbers of 94 and 100 respectively and can be blended with high grade gasolines and ethyl fluid to give aviation fuels of well above 100 octane. A large number of these units are under construction.

Hydroforming

The general process of taking a comparatively low-grade petroleum fraction in the gasoline or naptha range and subjecting it to some type of a cracking reaction to improve its antiknock qualities is called reforming. This can, and sometimes is, accomplished by thermal cracking but the yields are comparatively low and the improvement in antiknock qualities is limited by the choice of a feed stock that is susceptible to this type of treatment. The previously described process of polyforming is a method of accomplishing this result in combination with polymerization. A catalytic cracking reaction in the presence of hydrogen makes reforming more flexible for a greater range of charging stocks and produces a good yield of high antiknock gasoline by "hydroforming".

The operation of the process is similar to the other "fixed-bed" catalytic processes. The charging stock is vaporized, mixed with the recycled hydrogen, and passed over the catalyst bed under controlled pressure and temperature conditions and then condensed and separated into various fractions. As in the Houdry process, coke is gradually deposited on the catalyst making it necessary to regenerate by burning. Although the name implies a hydrogeneration process, the net effect is dehydrogenation. It is necessary to dehydrogenate in the presence of hydrogen to obtain the desired result. The improvement in quality is accomplished by converting the paraffinic hydrocarbons into aromatic compounds of high antiknock qualities. The first large-scale commercial hydroforming process was recently put into operation by the Pan American Refining Corporation. This unit takes a charge of 40-45 octane number heavy naphtha and reforms it with an 80% yield to 80-octane gasoline. By changing operating conditions, the hydroforming process can produce a high-grade aviation gasoline or it can be modified to produce a product containing upwards of 80 per cent aromatic hydrocarbons, principally toluene. This is an important feature from a military standpoint as toluene is the raw material used in the manufacture of T.N.T. This single unit could produce approximately 5,000,000 gallons of toluene a year or over 25 per cent of peacetime requirements.

Conclusion

These new refining processes have given us a source of high quality antiknock gasoline that could, if necessary, supply all the aviation fuel requirements with gasoline of 100-octane rating. This could not be done over night, but with some sacrifice in the quality of automotive fuels and some reduction in their general use, it could be accomplished in time. The petroleum industry has a remarkable record for being able to keep up with changing demands, and the active research programs of the various companies have developed the required new processes to produce the highest grade of aviation fuels. Even though the demand for such fuels should far exceed those of any other country, the United States will still have a better relative supply of "super fuels".

Plastic Planes In The Future?

Advantages and disadvantages of plastic - bonded plywood planes

GASTON R. DESNOYERS '44 ME

Cuts Courtesy MODERN PLASTICS MAGAZINE

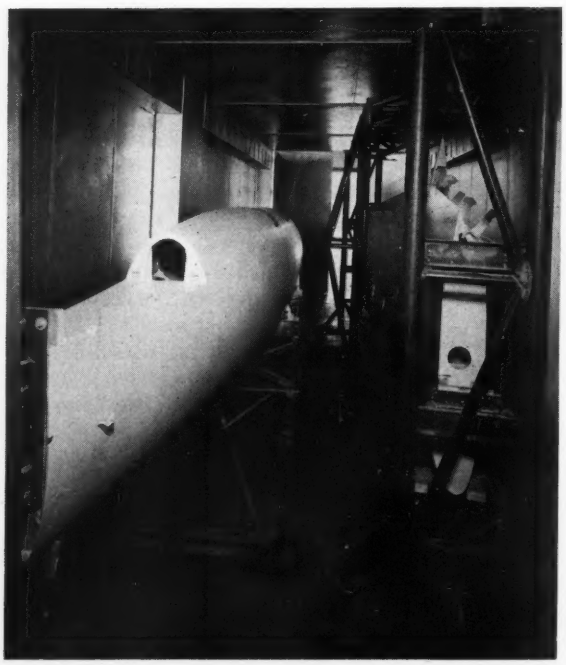
TWENTY years ago, when airplanes were largely made of wood, farsighted men in the aircraft industry envisioned the plane of the future as being built entirely of lightweight metal. Today, now that this dream has become a reality, the airplane industry in its constant search for further improvement, finds itself going back to wood as its basic material. What is the reason for this seemingly backward trend? Undoubtedly the present national emergency requiring many planes in a short time has been a contributing cause. The main reason, however, has been the development during the past few years of various processes by which plywood planes having most of the advantages of lightweight all-metal planes, but lacking many of their disadvantages, can be constructed.

What the airplane manufacturers are looking for is a method of producing more planes in less time and at a lower cost than at present. There are two general ways in which this can be done:

(1) by a combination of quantity production, cheaper processing methods, and low cost raw materials.

(2) by the simplification and standardization of the parts of basic airplane structure.

Even though technological improvement is continually going on, there is obviously a limit to the extent to which method No. 1 will increase production and reduce costs. On the other hand, method No. 2 can only be used with present methods of construction at the expense of a weight penalty. Standardization of parts is limited by the obvious necessity of saving structural weight. Were it not for the weight penalty, simplification of airplane structure would obviously be the best way to achieve low cost production. This would also reduce maintenance costs as the number of parts to be inspected and replaced would be reduced. Another advantage would be the reduction in joints and attachments, making for greater structural integrity and dependability. It is apparent that structural simplicity may be achieved without the usual weight penalties if a more suitable material could be developed. It is with this thought in mind that the experimenters have carried on their work, and their path has led them to plastic-bonded plywood.



Fuselage (left) and wing section (right) being baked in high pressure oven.

Superior To Metal

It is a fact that plywood was a very common material in airplane construction during World War I. Why then, if it is superior to metal, did manufacturers stop using it? The answer is, of course, that the plywood as used at that time was not superior to metal. There were various faults in the construction. The glues used were reversible glues; that is glues which would run when wet and become hard when dry or run when heated and solidify on cooling. When a plane made of plywood bonded with these various types of glues was exposed to wet weather or hot sun, the glues would soften and the plywood, forced into unnatural curves during the molding processes, would spring back into its original flat shape. These former difficulties have been corrected by the development of non-reversible glues and special molding processes which produce practically no internal stress in the layers of plywood, thus preventing any tendency for the veneer to slip back to its former shape. In this

way all of the strength of the wood goes to sustain the plane part.

At first glance, the claims of manufacturers seem extravagant. This new plastic-bonded plywood is said to be immune from corrosion, water proof, and resistant to fire. It is capable of being flexed to almost any shape and then set. It permits low cost production of mass quantities of smooth surfaced, lightweight, strong airplane bodies in one-tenth of the usual time. Actual tests have proven that plastic-bonded plywood structures are damaged less by concentrated gun fire than all-metal planes. This is a valuable asset from the military point of view. Another advantage is the fact that riveting, one of the chief bottle-necks in all metal types of construction, is entirely eliminated. It has also been found that the aerodynamics of the plastic planes are excellent. Their satin smooth surfaces contain no rivets, wrinkles, or lap-joints, a factor which reduces profile drag at normal speed from 30 to 50%. Various reliable tests have shown that all-plastic planes require 25% less power for a given speed than comparable all-metal planes. Many manufacturers claim that semi - monocoque plywood structures are 20% lighter than all-metal structures of the same strength. Still another advantage is the fact that the new plastic-bonded plywood structures may be repaired with a minimum of cost and delay while similar metal structures usually cannot.

Combustibility is a factor sometimes considered. Usually when a fire occurs in the air it makes little difference what material the plane is made of. Tests were, nevertheless, carried on. They showed that often the plywood would stand up while burning where metal structures would collapse because of heat. The possibility of damage by fire is further reduced by the fact that the wood is entirely coated with non-inflammable plastics.

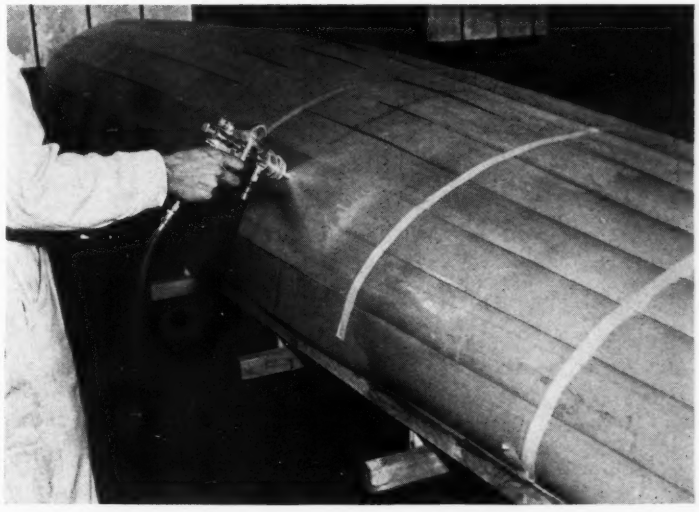
These results, and those of other tests, prove so convincingly the advantage of plywood construction that it seems entirely feasible that plastic-bonded plywood may eventually supersede the prominence of light metals in planes, except in the case of very large planes and in members with an enormously high concentration of loads at points of attachment.

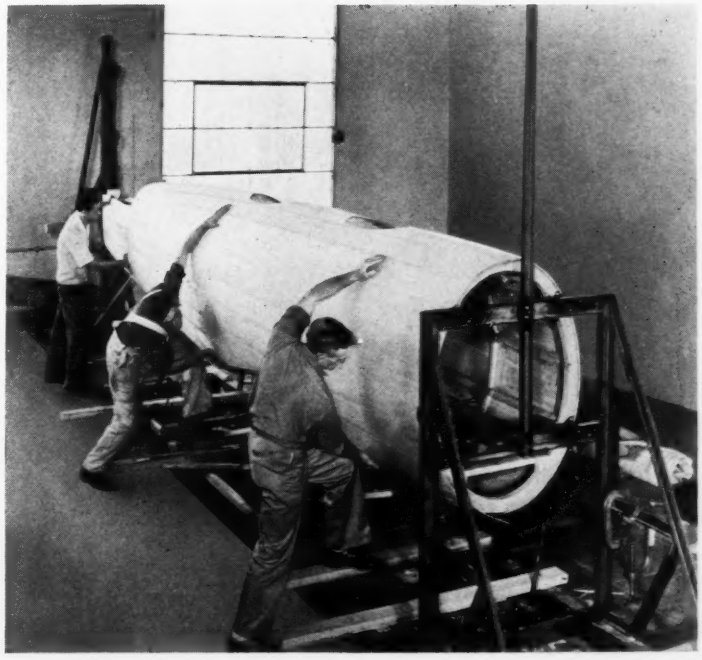
Plywood first began to sell when manufacturers started to employ exacting production control measures in the selection of strong, straight-grained, well-cut veneer so that plywood would be a uniform product of dependable strength. New non-reversible glues were developed. These were the synthetic resins more commonly known simply as plastics.

In the stressed skin type of construction used in airplane manufacture, the outside skin of the airplane carries a high percentage of the load. In order to keep the thin metal skins from buckling, a complicated internal structure must be built up and the skin riveted on the outside. The construction and riveting of this internal structure is what takes the greatest percentage of time and labor under present production methods. Plywood, on the other hand, because of its low specific gravity can be used in layers five times as thick without

Top: Spraying plastic on shaped plywood veneer

Bottom: Forming fuselage from two molded halves





any increase in weight. Because of the increased thickness, plywood skins are much stiffer and require little or no internal bracers and stiffness. They are stable enough against buckling to withstand loads of magnitude approximately equal to the ultimate strength of the plywood. Their elasticity permits stressing almost to the rupture point without deformation.

During the course of their work, research men tried other materials besides plastic-bonded plywood. Solid synthetic resin shattered on impact and was three times as heavy as wood. Molded wood fiber lacked the strength required, as did molded vulcanite. Only the combined effect of veneer's orderly arrangement of fibers and plastics' resistance to moisture, temperature, and other effects which the wood alone could not withstand, gives the perfect combination found in plywood today.

Parade of Plastics

It was in 1933, 1934, and 1935, that American research men first became interested in plastics, although several foreign nations—notably Germany and Italy—had carried on experiments previously. In 1937 and 1938 the number of concerns which conducted tests on plastic materials for application to the aviation industry increased considerably. Small companies were the first to come out with actual processes of construction. Haskelite, together with Fairchild Engine and Aircraft, came out with Duramold. Aircraft Research Corporation of Bendix, New Jersey, developed Gene Vidal's process for making Weldwood. Timm Aircraft of Van Nuys, California, came out with Aermold, which embodied a modified plastic bonding material. A new phase in aircraft construction had begun.

The Government soon took interest. A Plastics Section of the Bureau of Standards was opened under the sponsorship of the National Advisory Committee for Aeronautics. Summit built a body by the Vidal process. Other manufacturers began to use it. Timm made an Army trainer. Soon plastic-bonded plywood infiltrated into aviation from all sides. Today, there are few planes that do not use it in some parts and an ever increasing number are using it for monocoque and semi-monocoque structures. Even the most ardent of the metal advocates are softening up when it comes to plastic wings.

In most of the methods of manufacture the plastics are used in the form of large sheets of resin-impregnated tissue paper. Some manufacturers use the veneers in flat sheets and others in the form of interwoven inch-wide strips. The latter method distributes the direction of the fibers more evenly without sacrificing strength.

The molding processes roughly consist of applying heat and pressure to alternate layers of the plastic impregnated tissue and veneer to fuse the whole into a single unit. The plastic is softened and resolidified in its original form except that some of it will have penetrated the wood fibers enough to case the fusing of veneer on either side. Glues and adhesives that set colder and with less pressure are being tried.

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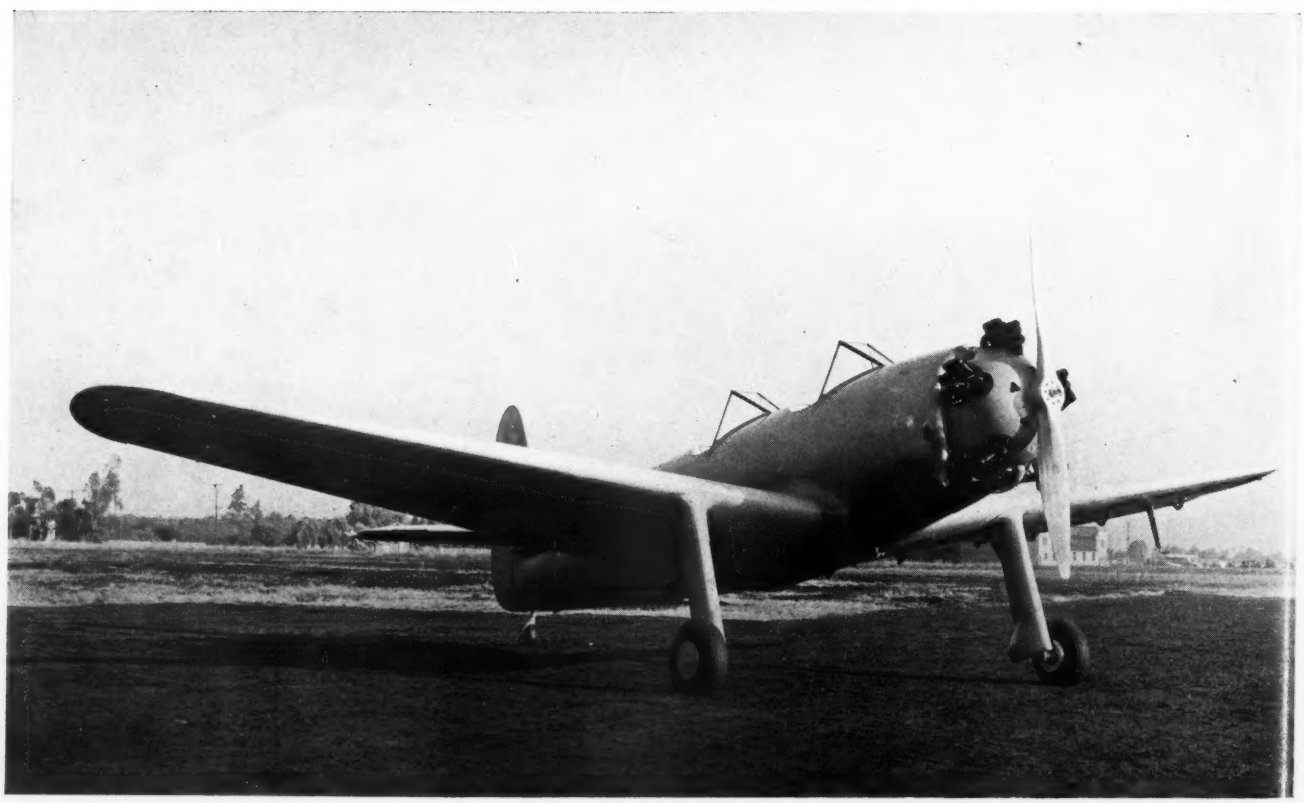
Primary trainer, built by Aermold process



Defense Power -- From Steam

ALFRED D. BLAKE, M.E. '07

—Cuts courtesy of Combustion Engineering Company.

THE importance of power in defense production has served to focus widespread attention on this phase of industrial facilities, particularly in view of the efforts being made by the Government, through the Federal Power Commission, to assure an adequate supply of power to meet both anticipated needs and all possible eventualities. The defense program has been expanded at such a rate as to require periodic revisions in the estimated power requirements. At present the installed capacity of the privately owned electric utilities throughout the country is approximately 39 million kilowatts, but additions now on order and under construction will raise this figure to nearly 44 million kilowatts by the end of 1943. In addition to this, between 6 and 7 millions capacity is installed in publicly owned plants and this is constantly being increased among the large Federal projects.

This is exclusive of the vast capacity installed in private industrial power plants and numerous munitions works erected under the direction of the Government, some of which involve large power installations. But power alone is not the only requirement; vast quantities of steam are required in many of the manufacturing processes, and this involves much steam generating capacity—the steam in some cases being supplied direct to the process, and, in others, after having passed through the turbines.

Unfortunately, the publicity accorded the numerous federally sponsored hydro projects has served to attach undue importance to this form of energy supply in the mind of the average man and to obscure the role of steam power in meeting the diversified requirements of industry. Water power has its place and certain large Government projects are admirably serving the Defense Program in providing huge blocks of power for the production of bulk materials in concentrated areas. But hydro power also has its limitations in supplying the general demands for electricity due to locations often remote from points of use—which requires long distance transmission—and to uncertainties in stream flow. The latter problem has recently been encountered in the South and in New England where the prolonged drought produced a serious power shortage on those systems that are dependent primarily on hydro power.

Steam Power—The Leader

To compensate for variations in stream flow it is often necessary to construct a series of dams and reservoirs, as in the case of the TVA which is now also building a large steam plant to supplement the hydro plants; but all this adds greatly to the initial cost and belies the popular conception that hydro power is synonomous with cheap power. Of course, there are a few favorable sites, such as Niagara Falls, where the foregoing does not apply.

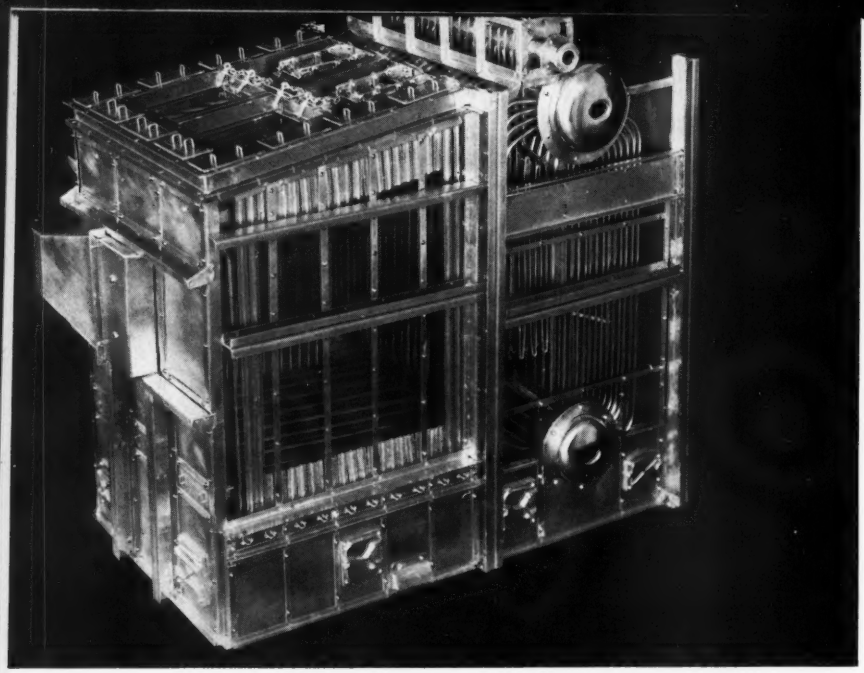
Statistics compiled and published by the Federal Power Commission covering the past twenty years, show that, despite a continual advance in total power output from all sources, the ratio of hydro to steam power has remained fairly constant for the country as a whole. This has ranged from 32.6 to 40.5 per cent for hydro and 59.5 to 67.4 per cent for fuel generated power, the figure for 1940 being 32.9 per cent hydro and 67.1 per cent fuel. These figures emphasize that steam power is the predominant source of electricity supply for public use in the United States and will probably continue so for many years to come.

In view of the present unprecedented activity in steam plant construction, both in new stations and in extensions to existing plants, it may be of interest to review briefly the progress that has been made in this field during the last twenty years—a period that has been productive of greater advances than any other period in the history of this industry. These advances, from the standpoint of steam generation, have involved the employment of high steam pressures and temperatures, very large steam

ALFRED D. Blake M.E. '07, editor of "Combustion" magazine, was, as an undergraduate, the editor of the "Sibley Journal." After graduation Mr. Blake worked for several years on power plant construction in the employ of Westinghouse, Church, Kerr, and Co. He then joined the McGraw-Hill Publishing Company and was managing editor of "Power" until 1932, except for two years during the World War when he served as a major in the Engineering Division of the Ordnance Department. Since 1933 he has been with Combustion Engineering Company, as editor of "Combustion" magazine and supervisor of technical publicity for that company.

A regular contributor to the New International Year Book, Mr. Blake is also a joint author of the Power Plant section of the Chemical Engineers' Handbook and author of the chapter on Boilers in the new edition of Mark's Mechanical Engineers' Handbook. During the last World Power Conference he was Chairman of the Round Table Conference Committee for the ASME.

In preparing this review of power plant progress the author has, in accordance with the policy of "The Cornell Engineer", avoided such technicalities as are usually encountered in power plant design and kept the treatment of the subject within the grasp of those engineers not familiar with power plant work. Due to space limitations, the text has been confined largely to steam generation.



Model of a two-drum steam generating unit

generating units, improved methods of firing, heat recovery equipment, automatic combustion control and ever increasing economy and reliability. From the standpoint of steam utilization, turbine improvements have been toward increased rotative speeds for the large units and refinements in design leading to greater economy. The net result of improvements in boilers, turbines, and auxiliaries has been a reduction in the average coal consumption per net kilowatt-hour output for all the central stations from 3.39 lb. in 1920 to 1.35 lb. in 1940. This means, if present operation were at the 1920 economy, approximately ninety million more tons of coal would be required by the central stations during the current year. It would represent not only an additional burden on mining operations and transportation facilities, but also an additional cost of several hundred million dollars.

In the early 'twenties maximum steam pressures were of the order of 275 to 300 lb. per sq. in.; steam temperatures seldom exceeded 700 deg. F. and a multiplicity of small boilers served the prime movers. Today steam pressures of 1400 to 1500 lb. are common and a few installations are designed for operation at 1800 to 2400 lb. although a considerable number of the new stations are laid out for 900 lb. Steam temperatures have advanced to over 900 deg. F. with 960 deg. F. as the present maximum. These increases in pressure and temperature have been made possible by advances in metallurgy and thus permitted taking advantage of the greater thermal economy of these higher steam conditions.

Increased Capacity

Although a popular capacity for central station boilers is from 400,000 to 600,000 lb. of steam per hour, many exceed this figure and there are at present in operation or under construction ten steam generating units of a million pounds per hour capacity. Instead of several boilers serving a single turbine, present practice favors a single boiler per turbine. This is because the reliability of the modern steam generating unit is now on a par with that of the turbine and consequently less reserve capacity is required.

The two factors most responsible for the advent of the large steam generating unit were the successful development of pulverized coal firing and he completely water-cooled furnace which permits higher rates of heat liberation than were possible with refractory-lined furnaces. While mechanical stokers predominate in the case of the smaller boilers and are competitive with pulverized coal in the medium capacity range up to about 200,000 lb. of steam per hour, above this pulverized coal firing is general, with a few exceptions. Of course, in certain localities where oil or natural gas are plentiful at attractive rates they are used as the primary or alternate fuels. This also applies to by-product fuels such as coke-oven gas, refinery wastes, wood refuse, etc. In many cases two or more fuels are burned simultaneously in the same furnace. As much as fifty tons of bituminous coal per hour may be consumed in the furnaces of some of the largest steam generating units.

A striking example of the progressive advance in boiler plant practice, as depicted in a single plant, is to be found at the Rouge Power Plant of the Ford Motor Company. This was laid out for eight 200,000 lb. per hr. units to operate at 240 lb. pressure and 600 deg. F. steam temperature. Four of these units were installed in 1920 and the remaining four in 1923. By 1926 four of these had been rebuilt, by the application of water walls, air heaters and additional burners, to produce half a million pounds of steam per hour, each. Three years later two of the remaining units were replaced by high-pressure boilers operating at 1400 lb. pressure and each having a capacity of 700,000 lb. per hr. Subsequently the two remaining original boilers were replaced, each by a steam generating unit capable of producing a million pounds of steam per hour at 1400 lb. pressure and 911 deg. F. total steam temperature. Thus, in the same floor space nearly three and one-half times the steam generating capacity has been installed, much of which is at nearly six times the pressure. These units burn both pulverized coal and blast furnace gas, and the high-pressure steam is supplied to three 110,000-k.w. turbine-generators.

To cite another example, when the Waterside Station No. 2 of the Consolidated Edison Company of New York, Inc. was rebuilt recently, ninety-six 650-hp low-pressure boilers were replaced by eight large 100-lb. pressure 900-deg. F. pulverized coal-fired steam generating units capable of supplying approximately three times the original capacity in the same building space.

Many similar examples might be

cited, but it will suffice to mention the Port Washington Station near Milwaukee which is noteworthy as having maintained a record for the past five years as the world's most efficient steam station with an average net station heat rate of approximately 10,800 Btu per kilowatt-hour output. Here the large single 390-lb. pressure boiler, which furnishes steam to a single 80,000-kw. turbine, has a furnace wide enough to accommodate a four-lane highway. A second, duplicate, unit is now being installed.

Although central station practice has led the way in power station development, industrial power plants have followed suit in adopting such of the refinements as best served their needs. However, except in a relatively few large condensing plants, initial steam pressures and temperatures are not as high, 400 to 600 lb. and 700 deg. F. being common steam conditions for the newer industrial installations. The usual heavy demand for process steam in such cases has been responsible for the widespread employment of back-pressure or extraction turbines, and moderate steam temperatures are sufficient to assure approximately dry saturated steam to process. Incidently, it may be pointed out that the steam turbine has steadily forged ahead in industrial power plant applications as shown by the latest Census of Manufacturers. According to this source, 70 per cent of the electric generators installed in industrial power plants are now driven by steam turbines and the use of steam engines has declined nearly 32 per cent during the last ten years.

Advances in steam plant practice have been accompanied by many problems which had to be solved step by step. When pressures and capacities were moderately low, feedwater presented no serious problem, but with the advent of high pressures and high rates of evaporation unexpected reactions began to appear. It then became necessary to prescribe the proper feedwater treatment to suit each individual case and to maintain a constant check on both the feed going to the boiler and the solids and gases contained in the boiler water, in order to prevent not only scale and corrosion but also to avoid the carry-over of solids to the turbine. This required the services of competent feedwater chemists and mechanical means for preventing the entrainment of solids in the steam.

Efficiency

Wide variations in the characteristics of coal, particularly the fusion temperature and other qualities of the ash, have entailed slagging problems in heavy-duty high-pressure, high-temperature units. These have now been largely reduced though modifications in design based on research and through changes in operating procedure. It is now quite usual to maintain boilers on the line continuously for many months at a time with high sustained efficiencies of the order of 80 to 85 per cent, and test efficiencies of 88 to 90 per cent are common.

Welding has played an important part in modern boiler construction. High steam pressures and large capacity often involve drum thicknesses as much as 5 inches or more. Instead of resorting to expensive forgings from the solid ingot, as was done in the case of the first few high-pressure units, the drums are now formed from plate on huge presses, the seams electrically welded and then annealed. Every inch of such welds is required by the A.S.M.E. Boiler Code to be carefully examined by radiographs for which X-ray equipment up to a million volts is now available. In fact, welding is now quite generally employed for drums with much thinner plates to operate at relatively low pressures and riveted construction is used only to a limited extent for very low pressure boilers. Welded construction has the advantage of precluding caustic embrittlement which at one time was so prevalent with riveted seams. Welded joints in power station piping is also becoming general practice.

Large units, high rates of forcing, and wide use of pulverized coal have been responsible for the development of equipment to arrest the fly ash which would otherwise discharge from the stack and create a nuisance to adjacent property. Such equipment may be of the electrostatic, cyclone, or wet-washing type. It is also now employed for stoker installations as well as pulverized coal. Many of the large heavy duty steam generating units have furnace bottoms of the slagging type in which the ash accumulates in molten form on the furnace bottom and is discharged continuously into a trough of water. In such cases only a fraction of the

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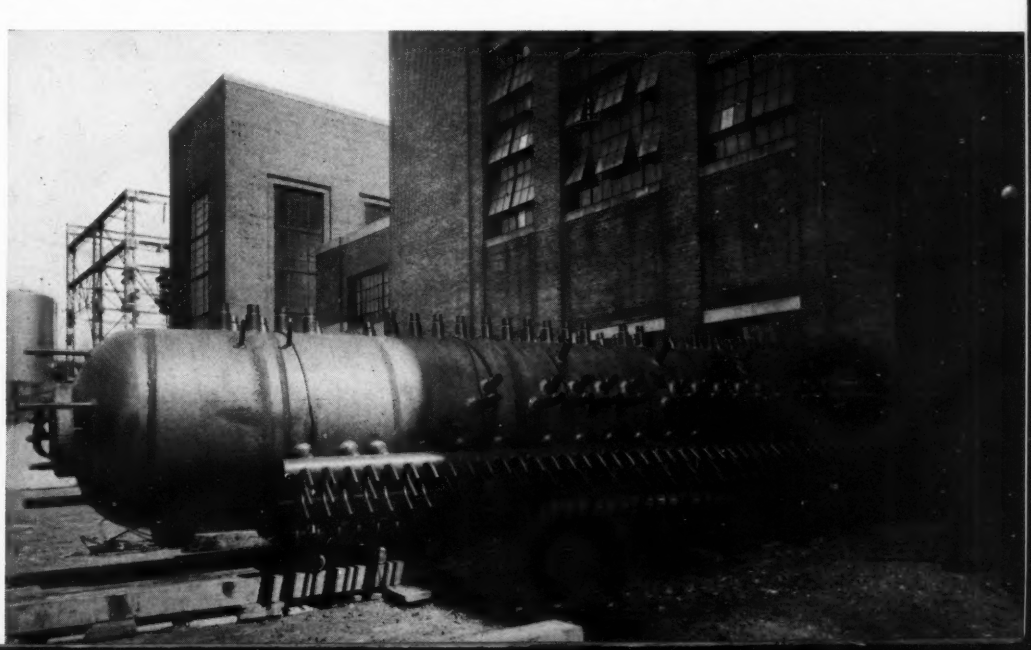


Steam drum of forced-circulation boiler for Somerset Station

The COLLEGE . . .

New Courses

THIS year, two revised courses for Sophomores and one revised course for Freshmen in the Sibley School of Mechanical Engineering have changed a long-established part of the engineering curriculum. Under the direction of Dean S. C. Hollister of the College of Engineering and E. H. Carruthers, assistant professor of materials processing, instruction in metals processing, casting processes, hot working processes, and welding has been introduced in the under-class program. The new courses are designed to give the student a background of forming, fabricating, and manufacturing methods. In place of manual training and development of skill, stress is placed on understanding the process involved in a given operation.

The Beginnings

The first hints of a coming reorganization became evident last year, when prelims were given in the pattern and machine shops. These, however, were but minor eddies washing into Rand Hall from a wave which began in the foundry and forge shop. Several months ago, Dean Hollister initiated a drive for new equipment; the successful conduct of this drive will shortly be marked by the completion of what amounts to rebuilding the foundry. Overhead monorail conveyors will carry molds from modern molding machines to a new and larger cupola which has been installed in a tall shelter, built last summer, against the building's north wall. After pouring and cooling, the castings will be shaken out and the raw sand transported to overhead bins where it will await reconditioning. Motor-driven mullers will be used to prepare the sand for use again, after which it will once more be stored in overhead bins until needed. Up-to-date casting-cleaning and refuse-exhaust machinery will supplement the old tumbling barrel process.

The mechanical equipment added has made it possible to design a revised course which will acquaint the student with the nature of most foundry operations and with the methods of modern foundry production. He will be made aware of the various types of sands and binders, of their specialized uses, and of the methods of testing and analyzing them. He will investigate molding as an operation rather than as an art, with emphasis placed on the part he may someday take in ordering a casting to be made. Before pouring a casting, the student will compute and make up the cupola charge, supervise the temperature and air pressure during the melting period, and finally, after pouring his casting, analyze his product.

As plans for reorganizing the foundry got under way, it was felt that the pattern-making and machine-shop courses should also be revised along similar lines. Consequently, students in these shops will henceforth spend more time learning the "why" of what they are doing. Under the new plan, the student in the pattern shop spends the greater portion of his time in discovering for himself how a pattern is to be made from a design drawing and how making it in a particular way fits in with the working out of the design and production methods to be used. So, too, in the machine shop, lectures and models will be used to teach modern methods, and up-to-date cutting materials and machines will be discussed when they cannot actually be demonstrated to or used by the student. In this way, the thought of finishing a given exercise will be subordinated, and the student will have uppermost in his mind the conception of production operations.

The Freshman Laboratory

In the Freshman Laboratory, exercises on the steam and gasoline engines, pipe and pipe fittings, and bearings have been eliminated entirely and supplanted by additional problems in the fields of hot working and welding. The student is to become acquainted with rolling, piercing, drawing, forging, extruding, etc., the various methods of welding and their applications, and the machinery for forming, fabricating, and welding sheet metal.

These revisions in the underclass course of study are well in keeping with the progressive policy of the College of Engineering. More and more every year, the engineer is called on to solve problems of production and production planning. Rapid advances in the fields of metallurgy and metals processing have been made in the past decade, and these advances, while expediting the work of the engineer and increasing his scope, serve also to complicate his problems of production. As he has always been, the engineer from Cornell will be fitted for his job by the training he receives; the revisions in shop work will help to keep the engineer from Cornell abreast of progress in his profession.

New Laboratory

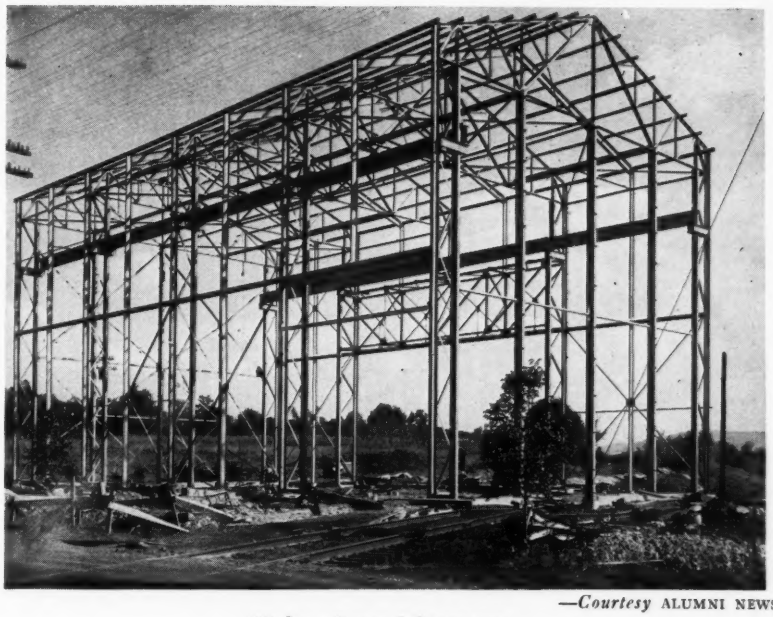
THE steel for Cornell's new $150,000 high voltage laboratory is now in the process of erection at upper Mitchell Street in East Ithaca, under the supervision of Dr. Raymond W. Ager, newly appointed associate professor of electrical engineering. The laboratory is designed for research in problems arising within the transmission lines, transformers, and machines of a power system, and those caused by lightning and other forces outside the system. For this purpose, it will have 60-cycle and impulse testing equipment.

Lattice columns, 54 feet high, are already installed. The steel frame structure, weighing 117 tons, and its sheet metal exterior of 32,000 square feet, are expected to be ready for occupancy by the first of the year, according to Dr. W. A. Lewis, Director of the School of Electrical Engineering. The structure has been especially designed to eliminate radio interference, which otherwise might prove objectionable. The steel for the building has been given preferential handling as necessary to the defense program, but a number of small items have struck priority snags. These, however, are being

rapidly ironed out. When the building is completed, Cornell will have facilities unparalleled by any other eastern university in this field.

Much of the special equipment, already ordered, will be installed as soon as the building is completed. The 60-cycle equipment will provide voltages sufficiently high to test apparatus above the maximum of 287,500 now used commercially. The impulse testing equipment will simulate natural lightning up to 3,000,000 volts.

The building itself will be 71 feet high, the equivalent of a six story structure. The inside of the building will be open to the roof except for an observation balcony. An office, shop, control room, and rooms for the power plant and furnace will be located in the building. More than a half-mile of conduit and more than four miles of wire will be needed for the wiring of the building. A spur of railroad track will enter the building and end on the main test area of the laboratory, so that equipment sent by various commercial firms to the laboratory can be tested directly on the flat cars in the laboratory itself. Two large doors, one 30 feet high and 60 feet wide, the other 23 feet high and 28 feet wide, will permit bringing the large type equipment into the laboratory for tests.



—*Courtesy* ALUMNI NEWS

High voltage laboratory

New Book

DURING the summer Professors John R. Bangs, Jr., and George R. Hanselman wrote a book entitled *Accounting for Engineers,* which is being used this fall by engineers taking the accounting courses.

Realizing that a good knowledge of accounting is essential to engineers—especially those looking forward to executive positions in engineering concerns—the authors have presented the subject in a new and interesting manner and at the same time overcome some of the difficulties formerly encountered in presenting accounting to engineering students.

Accounting for Engineers remedies these difficulties by using a unique teaching device, a chart known as a diagrammatic ledger, which shows a representative number of ledger accounts suitably classified on one page. This enables the beginner to visualize the transaction more easily and better understand the double entry system.

Besides presenting the fundamentals of accounting, this book discusses the essential features of accounting for manufacturing cost systems and standard costs.

Architects' Fun

THOSE inimitable jokers, the architects, held their annual freshman picture-taking party on the steps of White Hall on the morning of October 10. By some uncouth trickery they inveigled one of those traditionally superior frosh engineers (his name has been closely guarded to help him avoid complete disgrace) into the gathering and at the click of the shutter all the subjects were thoroughly drenched from the upstairs windows of White.

The trusting frosh architects were speechless; the lone engineer's only comment was ?*!*?; while campus opinion has it that it was the first bath any architect had had in weeks.

The moral of this story, Frosh, is never trust an architect or you too are likely to have a photo-finish.

The Freshman architects receive the blessings of their upperclassman.

Faculty Appointments

TWELVE new appointments have been made in the College of Engineering including three assistant professors and nine instructors, Dean S. C. Hollister has announced.

The new appointees to assistant professor in the Sibley School of Mechanical Engineering are George H. Lee and W. T. Thomp-

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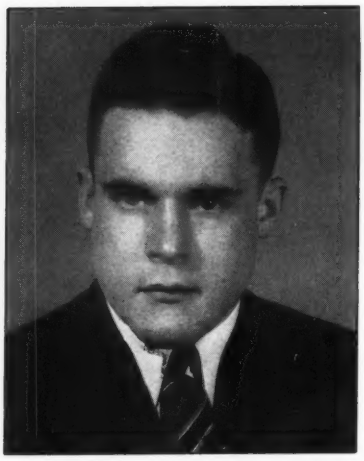


"Powerhouse" Wolff

Peter M. Wolff, AE

HAD you seen Pete Wolff limping around last June after the knee operation necessitated by an injury in the Dartmouth game of "fifth down" fame, you never would have thought he'd be in the game playing such brilliant ball this fall. But 200-lb. Captain Pete is too much of a veteran player to be cheated out of a season of football. His interest and participation in the game date back to his high school days at Highland Park, Illinois, and while here at Cornell he was blocking back on the freshman team and for the past three years has filled the guard position on the Varsity.

Pete's summer activities are a further indication of his interest in football, for during a part of each of the past three summers he has had what might be compared to a football compet's job at the All-Stars Football Camp in Wisconsin. He goes out there because he likes the work and wants to learn more about the game. His working experience includes that as counselor at a boys' camp in western Ontario, labor drilling and dynamiting rocks, labor in a gold mine in Nevada, and ditch digging. Pete, as you can see, is definitely an outdoor man.

Pete is not wrapped up in football to the exclusion of everything else, however. In addition to being captain of the Varsity team, he is president of Quill and Dagger and is a member of the Football Club, Red Key, Freshman Advisory Committee, Scabbard and Blade, Officers' Club, and a wearer of the "C".

Add to these the groups in which he was active in his first three years—such as member of the Student Council, Navy Day Ball Committee, chairman of the Freshman Banquet Committee, and treasurer of the Campus Chest Committee—and you have enough shingles to completely cover every spot on the wall of any room. Pete is also a member of the Cornell-Ithaca Co-operation Committee, a group which, as the name implies, tries to promote good feeling between the merchants and the students; the committee succeeded in getting the prices of the movies reduced only to be thwarted shortly thereafter by Uncle Sam's imposing a 10% amusement tax.

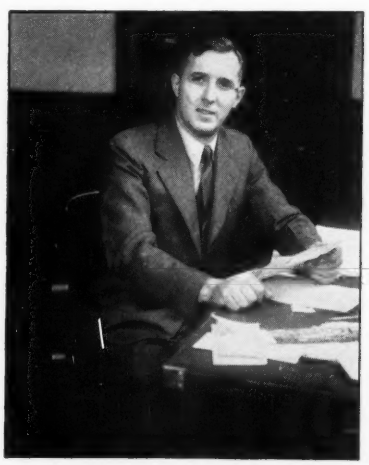
This June Pete will receive his reserve commission in the Ordnance Department and without doubt will be called to active duty shortly thereafter.

Prof. E. H. Carruthers

PROFESSOR Eben H. Carruthers is perhaps the only man in the history of Cornell University who came to Cornell because he was legislated out of business by a state assembly. This happened out in Astoria, Oregon, where Professor Carruthers was born. After graduating from high school there, he became engaged in the manufacturing and marketing of a salmon-egg fish bait intended primarily for the big salmon of the Columbia River. Not only did the intended victims rise to the bait, however, but Professor Carruthers' product was attractive also to trout, a fact well appreciated by hundreds of pleasure fishermen. Very soon there began to be a shortage of trout in Western streams, and the Oregon State Legislature, together with several others, stepped into the picture. When they had stepped out again, Eben Carruthers was looking for something else to do.

Shortly after this, Professor Carruthers entered Oregon State Agricultural College, meanwhile toying with the idea of going east to school. It was a talk with a professor from Cornell University which finally effected his decision. After completing half a year at Oregon State, Eben came to Ithaca and entered the Sibley School of Mechanical Engineering.

During his three and one-half years as an undergraduate, Professor Carruthers rowed on the 150-pound crew and the "Sibley College Crew", and played flute with the Musical Clubs. He was initiated into Tau Beta Pi in his Junior year, and graduated in 1929 with an M.E. degree. Graduate research work followed for the next four years. This research work in crucible furnaces led to the development of improved crucible melting equipment, made possible by an oil burner with which the furnace atmosphere could be selected and maintained to very close limits. In



"Inventor" Carruthers

1932, while still engaged in his research work, Professor Carruthers was made a member of Sigma Xi, honorary scientific society.

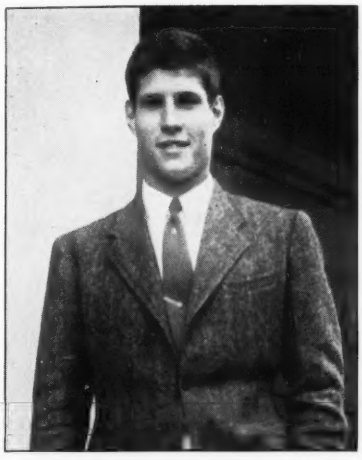
The manufacture of ornamental wrought iron, at which he once spent a winter, is the basis of Professor Carruther's interest in metal processing. As part of this job, he helped to design special machinery, and today he uses his rather scarce

(*Continued on page* 30)

...ong Cornell's Engeers

W. Nicholas Kruse, ChemE

FOUR years ago an old red Chevrolet brought a tall blond boy from Iowa to Cornell. Today the Chevrolet is still on the "Hill" giving Jim, the campus cop, headaches, and the boy is now one of Cornell's leading student figures.



"Crew" Kruse

"Nick" was born and raised in Davenport, Iowa, or as he laughingly puts it, "down where the tall corn grows." Due to an early love for boats, and sailing in particular, which was developed along the Mississippi River, Nick planned to attend Annapolis; but he decided to put several irons in the fire and so applied for a McMullen Regional Scholarship. When he discovered that he had been awarded the scholarship, he was more than a little surprised; but quickly recovering, he decided to give up dreams of a life at sea.

His next problem was to decide which course to follow at Cornell. Because he had no particular choice of schools, he chose Chemical Engineering, after carefully looking over his high school grades and discovering that his marks in chemistry had been especially good.

Finally arriving at school, Nick enrolled and then set out to follow in his brother's and father's footsteps here at Cornell. He headed for the boathouse and a seat at stroke of the freshman crew. The past two years have seen him jockeyed back and forth to various positions on the port side of the Varsity and Junior Varsity shells. Crew has not been his only interest either, for he has spent considerable time on the Freshman Advisory Committee, and this fall he served as a counselor at Frosh Camp. On top of these he is now serving as house manager and treasurer over at the Beta house.

Although outside activities have occupied a good part of his time, he has certainly not neglected the other aspects of Cornell life. He is a student, a fact easily verified by a glance at the wall of his room where there hangs a Dean's List certificate.

In recognition of his efforts in the direction of scholarship, activities, and service to the University Nick has been elected to Tau Beta Pi, as one of two Junior members. He has also been elected to Retort and Beaker and Al-Djebar in the Chemical Engineering School, and Scabbard and Blade in the Military Department. He was successively tapped by Aleph Semach and Sphinx Head, and is an active member of the Crew and "C" Clubs.

Paul W. Leighton, CE

THERE are a lot of engineers on this campus who manage to keep up scholastic averages and be engaged in a few activities too. But Paul Leighton puts this group to shame by being one hundred per cent self-supporting as well. When he graduated from high school in Twin Falls, Idaho, Paul didn't think he was going to college at all. However, he drew lots with fortune and pulled the long straw—a John McMullen Regional Scholarship, which brought him to Cornell.

Realizing that he would be too busy in the afternoon to participate in athletics, as he had done in high school, Paul invested his "spare" time in evening activities. He has been active in the Dramatic Club, Radio Guild, American Society of Civil Engineers, and in Willard Straight Hall. This year he is chairman of the Willard Straight Hall Board of Managers, and president of the Congregational student group, as well as being on the C.U.-R.W. Student Board.

Perhaps his most remarkable achievement was to win the Guilford Essay Prize, the University's highest honor for writing, in his sophomore year.

Paul's natural ability in military science has been recognized by his election to Scabbard and Blade and nomination as the outstanding junior R.O.T.C. cadet in the infantry.

Grades? We'll just mention the fact that he won the John Knickerbacker Bursary, and was elected to Chi Epsilon in his junior year.

Because his interest in Civil Engineering is quite general, Paul is not specializing in any one phase of it. The summer after his freshman year he worked as a surveyor and timekeeper in a large migratory workers' camp which was being constructed in the West by the National Government. The next year he really kept on the move, spending six weeks at R.O.T.C. camp, five weeks at surveying camp, and the remaining weeks in Ithaca doing statistical work for the College of Engineering. This past summer he worked as a supervisor on a large three million dollar project at Newport News where the Navy is building two ultra-modern ship ways.

Just a short survey of Paul's college course to date is enough to convince one that his energy, resourcefulness, and ability will be very welcome to any employer.

"Manager" Leighton

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80 Park Place, Newark, N. J.

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the College and the alumni."

President's Message

Fellow Cornellians:

The activities on the Campus which the students observed upon their return this fall, and which will be apparent to graduates when they make a home-coming visit, will naturally center on the construction of Olin Hall, the new building generously given to house the Chemical Engineering department—something sorely needed. Its location will cause some concern among those who treasured the wide open spaces of the Campus, and the hope that these might always remain a feature of Cornell. But time marches on, and traditions must give way to necessity; so the decision of the Trustees in their planning of the Campus must be accepted.

This construction, a fore-runner of other buildings planned for the Engineering College, designed to supersede Sibley and Lincoln, and perhaps some of the other buildings on the northern end of the Quadrangle, invokes some speculation. Some may have seen the brochure which has been prepared setting forth the needs of Cornell from the engineering point of view. It is entitled "The New Challenge to Engineering" and admirably presents a program for strengthening the College. This program contains three main provisions: I—an increase in the endowment for faculty salaries; II—a large amount of equipment in order to maintain standards of instruction and leadership in research; and III—replacement of present buildings and an adequate endowment for maintenance.

The order in which these objectives are placed is logical, and it is to be hoped that it will be followed assiduously. Any change in this, or any effort directed toward one of the objectives to the disadvantage of the others would seem to be productive of dissonance. It goes without saying that the results secured at any institution of learning are almost directly proportional to the quality of the teaching. The history of Cornell, especially in the formative years, speaks eloquently of this, and the brochure does honor to many of those who created in the institution the leadership which it once held undisputed. But as time went on and characteristics in the world changed, the matter of compensation seemed to lag behind, and with it came an obvious retrogression in this standing. Man must live, and to live, he must have the necessities of life and some of the comforts. To be sure, there are some who would forsake many of these and even suffer hardship for an ideal, but inevitably the ability to earn more with the same effort in adequate and comfortable surroundings will prevail against tradition and love.

C. Reeve Vanneman

In salary range Cornell has for some time been lagging and it is high time that some thought be given, and that there be some action. The endowment of a professorship does not carry with itself so much appeal as does the erection of a building. There is little glamor connected with a listing in a book, and few would associate the name of a donor with the individual who goes about the Campus performing his appointed rounds. But the fact remains that unless there be such endowments the teaching staff of Cornell has little hope of competing with other institutions where endowments are adequate and sometimes almost profligate.

So to me it appears paramount that before anything of magnitude is done concerning buildings and equipments, a major effort should be made to secure an adequate endowment for the teaching staff. Right here something may be said concerning this word teaching. In engineering, at least, this word is significant. Graduates can easily recall professors and instructors who were real teachers, those men who inspired their students and possessed the ability to impart their knowledge in a manner which made it relatively easy for the student to

(*Continued on page* 24)

Here come *life lines* of national defense

Additional telephone lines speed defense everywhere.

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Telephone lines are life lines. They carry the communications so vital to our expanding defense program.

The photograph shows wires being made into a telephone cable. Such cable—containing billions of feet of this wire—is being rushed by Western Electric to meet the urgent telephone needs of the armed forces and of industry.

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The ALUMNI . . .

Honorary Degree

HENRY Sylvester Jacoby, who was for 32 years (1890-1922) professor of bridge engineering at Cornell University, was one of eight men to receive honorary degrees from Lehigh University at the annual Founder's Day exercises on October 3. The exercises were a part of the University's three-day observance of its 75th anniversary. Professor Jacoby, who was graduated from Lehigh 64 years ago, was granted the degree of Doctor of Engineering.

Doctor Jacoby is a former president of the Society for the Promotion of Engineering Education, a member of numerous other societies, and the author or co-author of seven textbooks in the field of civil engineering. Following graduation as a civil engineer from Lehigh in 1877, Dr. Jacoby served as chief draftsman, U. S. Engineering office, Memphis, Tenn., and then became instructor in civil engineering at Lehigh, 1886-90, before coming to Cornell.

ASME Elects

JAMES W. Parker, M.E. '08, vice-president and chief engineer of the Detroit Edison Co., was elected by a letter ballot of the 15,000 members of the American Society of Mechanical Engineers to be president of the Society during 1942, according to the official announcement of the election results by C. E. Davies, secretary of the Society. Managers of the Society elected to serve on the Council for three-year terms include W. G. Christy, M.E. '11, smoke-abatement engineer of Hudson County, New Jersey, and T. S. McEwan, M.E. '11, who was last year selected to head the defense contract service of the Office of Production Management in Chicago as district manager. The new officers will be installed during the 62nd Annual Meeting of the Society in New York City at the Hotel Astor, December 1-5, 1941.

Alumnus Writes Treatise

JAMES P. Stewart, M.E. '28, is co-author of a treatise entitled "American Experience with Buchi Turbo-Charging" which recently appeared in the *Society of Automotive Engineers Journal.*

The Buchi system, according to the paper, is a relatively simple and foolproof means of supercharging diesel engines. The paper also states that supercharged engines will be used increasingly in the future and in time all four-cycle internal combustion engines will not only be supercharged in some form but will be designed specifically for supercharging.

After his graduation from Cornell, Stewart joined the Elliot Co. in the capacity of sales engineer in the Centrifugal Blower Department. He became head of that department in 1940 and was made manager of the Supercharger Sales Department in the spring of this year.

Article On Materials

THOMAS Ashley Bissell, a graduate of the College of Engineering, Cornell University in 1923, is the author of an article "Designing for Alternate Materials" which recently appeared in the *Society of Automotive Engineers Journal.* The paper was prepared in response to a request of the Passenger-Car Activity Committee of the Society for a report of the work done by engineers in automobile equipment and accessory companies in substituting plentiful alternate materials for critical shortage materials urgently needed in defense. The major part of the paper reports the work done in replacing aluminum, nickel, zinc, and Neoprene—all of which are on the OPM mandatory priority list or under partial control by this body.

The author points out that even though substitutions are being made for critical materials, they will not lower the standards of safety, durability, performance, and comfort established in 1941 passenger cars. However, in virtually all cars, parts of alternate materials cost more than do the original parts of the critical materials.

After graduating from Cornell, Bissell became a plant engineer and then worked for eight years in production and sales engineering. Since then he has been doing technical editorial work. He first worked with *Maintenance Engineering* and since 1935 as technical editor of the *SAE Journal.* He is also the author of the article on automotive engineering covering the 1941 cars published in the current edition of the *American Year Book.*

Employment Service

IN ORDER to be of greatest possible assistance to those companies needing engineers today, as well as to promote as many opportunities as possible for Cornell engineers interested in improving upon or changing their present jobs, the University Placement Bureau has begun to publish *"Men Available"* Bulletins. Five issues have been sent since last June to a list of nine hundred and fifty selected com-

Use The Cornell University Placement Bureau

WILLARD STRAIGHT HALL — H. H. WILLIAMS, '25, Director

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panies throughout the country. Each issue contains a brief sketch of the experience and backgrounds of about fifteen men.

To date the results of this effort have been most encouraging. One hundred and sixty-one companies, seventeen percent of those on the mailing list, have written in concerning individuals whose qualifications were of interest. Seventy-four of the one hundred men listed have been among those about whom companies have inquired. Altogether three hundred and four records have been sent out for these seventy-four men, as many as forty-eight companies being after one engineer. The net result of all this has been a number of men placed in new jobs of more interesting character or at better salaries, with a large number of other jobs still in the negotiation stage.

Other Cornell engineers may wish to participate in this effort. The Placement Bureau will be glad to extend its service and will welcome inquiries as to registration procedure. Those who live in the New York City area should call on Mr. P. O. Reyneau, Manager of the Cornell Club Employment Service. Others should write to the Placement Bureau at Willard Straight Hall, Ithaca.

Former Editor In Army

SECOND Lieutenant Robert Ross, AEME '41, former Editor-in-Chief of the CORNELL ENGINEER, has been assigned to the 101st Signal Battalion at Camp Shelby, Mississippi. His first assignment was to act as a message center officer supervising the handling of messages by such means as telephone, telegraph, teletype, motor messenger, pigeon, and airplane.

The 101st Battalion joined the 3rd Army during practice maneuvers this summer in Louisiana. From the war games, Ross reported: "We move with the army command post and have been leading the life of gypsies. Each move of 40 to 60 miles is made over dirt roads in anything from a jeep peep to a pole digger. Two or three days in one place is a long time. I have been working nights, usually on a twelve hour shift, and trying to sleep days. In spite of the oppressive heat, dust, and insects, I am enjoying myself roughing it in this Louisiana country."

After the war games Ross returned to Camp Shelby, where he is now waiting for his next assignment.

Afghanistan Official

KABIR M. Ludin, an alumnus of Cornell University who took the C.E. degree in 1936 and the M.C.E. in 1938, is now director of irrigation for Afghanistan.

After coming to Ithaca from the Orient and finishing his academic work at Cornell, Ludin worked for a year with the U. S. Bureau of Reclamation in the Denver office before returning to his native country. For two years he has been employed by the Afghanistan Department of Public Works.

Plastic Planes

(*Continued from page* 10)

In the Vidal process, a wooden male mold of the exact inside proportions of the plane part, is made. Veneers, cut on a blanking die to the desired flat patterns are placed over the inside mold after having been dipped into a resin solution and allowed to dry. The layers of veneer, together with the mold, are then put into a rubber bag and the air withdrawn. This bag eliminates the expense of an outside mold. Next, the rubber bag and its contents are placed in a large steel tank and steam pressure applied for the required length of time. When the part is removed from the tank after the required length of time, it is ready for the assembly line.

The Duramold process is similar to the Vidal process in the molding except that the outside mold is rigid while the mold that forms the inside is in the form of a huge rubber bag. The outside mold, of sheet steel, cast iron, or wood, provides a solid base for molding the desired shape while the use of the rubber bag insures equal pressure, applied perpendicularly to all points of compound curved surfaces. The part to be molded (whether wing, nacelle, pontoon or spar) is built up in alternate layers of plastics and veneer until the desired thickness is obtained. The rubber bag is placed over the whole, and then the entire assembly is placed in a tank and the desired heat and pressure applied. This varies for different parts and is determined experimentally. A part ½ inch or less in thickness requires about 15 minutes of this treatment. When the part is removed, the surface is finished, and it is ready to be assembled.

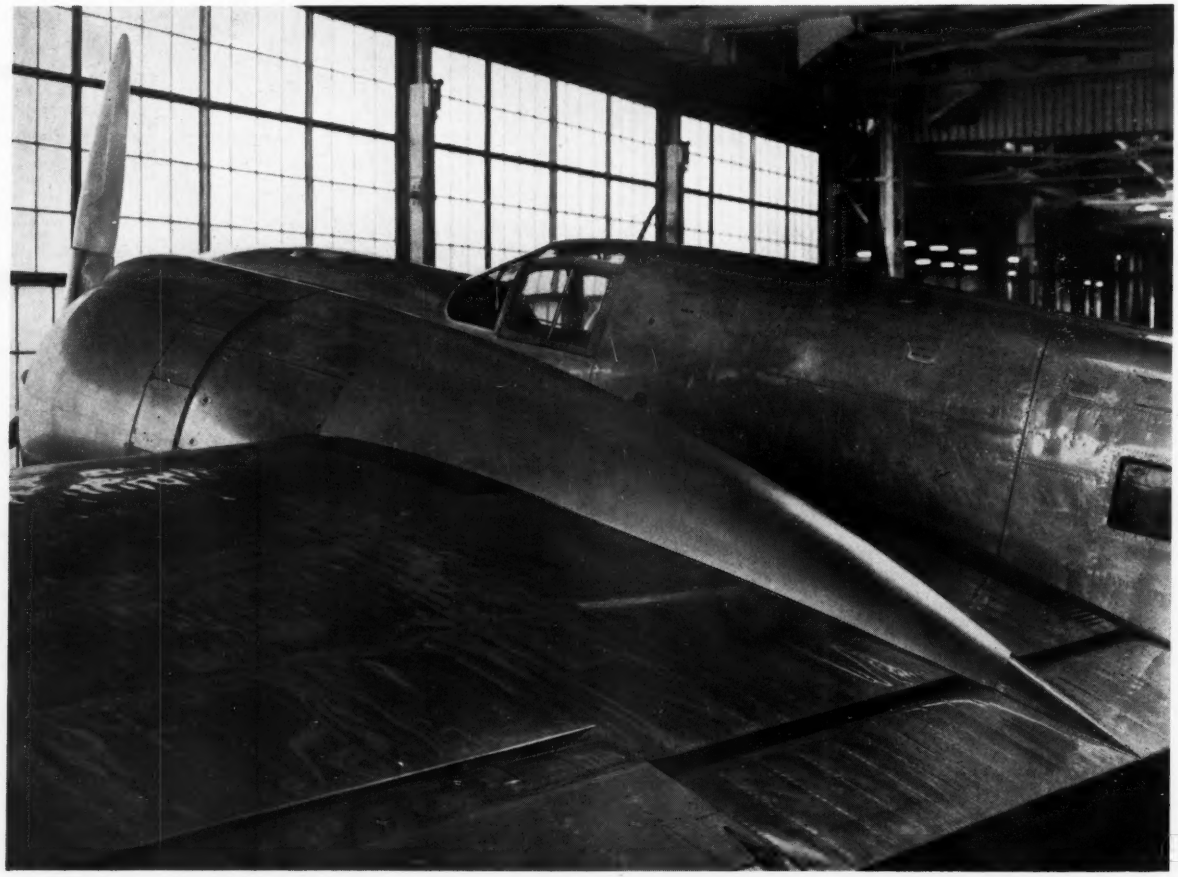
The third of the important processes in use today, the Aermold process, differs from the other two in that the shape of the part is stamped out on the sheets of veneer before the resin is applied. This is done by heated presses and precision molds which give the veneer the desired contours. The secret of the process is a plastic which does not require a great deal of heat or pressure to set. Alternate layers of veneer and plastic are heated in a 10 x 10 x 40 foot oven at 100° Fahr., a treatment which fuses the layers together. They are then removed and assembled on a skeleton framework. This is accomplished by a master clamping arrangement which holds whole wings and fuselage sections on the frame at once. The finished assembly is baked for two hours at 188° Fahr. This baking fuses the separate elements into one single plane mass. Finally a plastic paint is applied, giving a mirror-smooth surface. This process is used by Timm Aircraft.

Although methods of production and processing are varied, all three of the processes provide the same basic advantages.

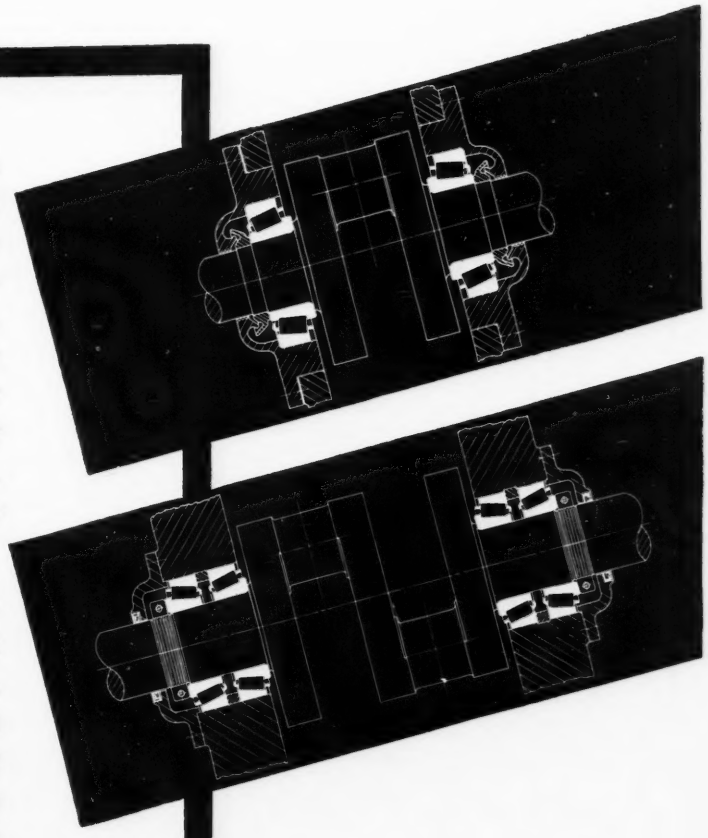
1. They seal the wood and so make it waterproof, oilproof,

(*Continued on page* 24)

Engine cowling produced by Duramold process



WHAT BEARINGS WOULD YOU SPECIFY FOR THE CRANK SHAFT OF AN OIL FIELD ENGINE?



If you were called upon to design a gas, Diesel or steam engine for oil field work how would you support the crank shaft? If you knew your bearings you wouldn't have to think twice. You would do as most of the leading engine builders do; you would mount the crank shaft on TIMKEN Tapered Roller Bearings—single or double, according to the length of the shaft and the H.P. of the engine.

This would assure a smoothly-operating engine that would transmit its maximum power rating to the job, for main bearing friction would be eliminated. Full protection against both radial and thrust loads would be assured. Wear on the ends of the crank shaft would be prevented because all movement takes place within the TIMKEN Bearing itself. Main bearings would seldom, if ever, have to be replaced on account of wear. Crank shaft alignment would be maintained indefinitely.

You can learn a lot more about crank shaft bearings and many other applications by studying the Timken Reference Manual. We will gladly send you a copy. Write for it. Know your bearings—be a better engineer.

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Plastic Planes

(*Continued from page* 22)

free from bacteria, fungi, and insects, and actually more resistant to fire and shock than aluminum alloy.

2. The parts may be constructed in one-tenth the usual time, with secondary reinforcing members such as stringers and ribs either entirely eliminated or greatly reduced in number as compared to the all-metal type of construction. This is because the thick skin can by itself carry large compression, shear, and tensile loads.

3. The resulting plane has 30 to 50% less profile drag because of the elimination of rivets and joints, two main causes of drag.

4. Less power is required to fly at a given speed because of the reduction in drag.

5. A substantial reduction in cost of production and maintenance is achieved.

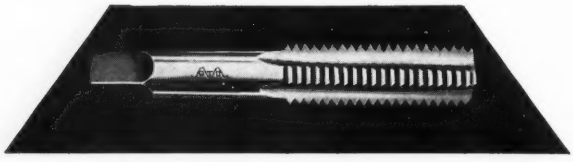
With these results already obtained, and constant research going on in the continual striving for improvement, it seems entirely possible that planes made of plastic and wood may be the means of winning World War II. Perhaps, too, plastic airplanes will someday become so cheap to build that they will be almost as commonplace as automobiles are today.

President's Message

(*Continued from page* 18)

understand and absorb. It is equally easy to recall others who were scholarly in their attainments, but did not possess one iota of this teaching ability and went through the motions of instruction in order that they might have the opportunity to pursue some investigation in which they were interested. In this condition, there is an inherent danger. Students attend an institution for instruction. They pay a tuition, which they construe as payment for such, even though the amount may not in fact cover the actual cost. They are entitled to some consideration, and therefore it seems to me that to place undue emphasis on research may lead to a brand of instruction which is not adequate and which will not reflect the credit due. It is rather stretching things to assume that one interested primarily in research may be an outstanding instructor. There may be exceptions, but the two things hardly mix. One carries with it the onerous work of repetition, the dealing with minds which are not all equal in ability to absorb, while the other presents new fields, ever widening and ever attractive on account of the failures and ultimate successes. It is obvious that one will be borne perforce, while the other will attract. There should be some middle ground. Re-

(*Continued on page* 30)



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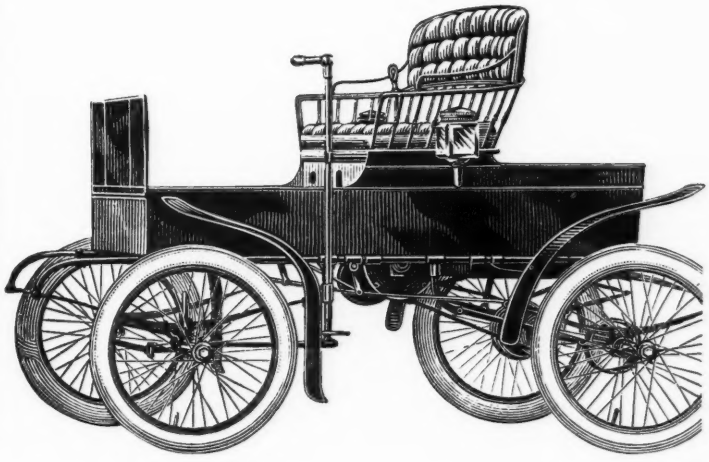

"Positively the most perfect machine on the market" was the manufacturer's description of this horseless carriage in 1900. And only the rich could afford such perfection. Parts were finished by hand. Interchangeability of parts was unheard of. Then came man-made abrasives such as "Carborundum", and later "Aloxite", to help bring about the mass production that has made available to everybody that miracle of transportation—the modern American car.

The use of man-made abrasives made it possible to finish parts to uniformly close limits of accuracy. Interchangeable crankshafts, cams, cylinders, pistons, gears could be produced in quantity for instant assembly. Better-built cars became available at new low prices. And the same mass production methods extended to other products have helped bring us a new standard of living.

A leader in the advancement of grinding, Carborundum now supplies abrasive products for obtaining finishes of unbelievable accuracy. No matter what type of industry you may be identified with after graduation, you will find it profitable to use Carborundum engineering experience. The Carborundum Company, Niagara Falls, N. Y.

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The ENGINEER Comments:

Shortened Year?

A FAVORITE topic of conversation these days is the proposed shortening of the school year. The plan, as proposed to the Faculty, would eliminate the spring recess period and cut out the second week of each final examination period. Contrary to popular opinion, Junior Week would not be eliminated. This plan would benefit (according to the authors of the proposal) the engineers, the Ag students, and the Army. It would aid the engineers by letting them get to work earlier, which would in turn mean a contribution to national defense. The Ag students would be released to the farms during a period when cultivation is very important to the outcome of the year's produce. The Army would have the resources of Barton Hall for some unspecified purpose. These factors are the basis of the discussion.

How It Started

The Faculty sees no reason for any heated reaction from the student body; the Faculty is merely considering a polite suggestion made by the College of Agriculture. It all started when the Agriculturists found that the farming situation of New York State was being endangered by the shift of farm labor over to the more lucrative jobs in defense industries. The solution to the problem as they saw it: release the Cornell Ag students at an earlier date so that they could help save the farms. The idea sounded good enough to bring up at a Faculty meeting. To the original plan was added the advantages which would come to the engineers and the Army; these advantages being an afterthought.

There are a few things which the Faculty did not visualize. The elimination of spring recess will result in three distinct liabilities. (1) A much-needed rest period will be cut out, with the obvious results on a student's efficiency. (2) The plans for job-hunting during this period will have to be scrapped. Many students depend on this period for their interviews for summer jobs and for permanent employment. (3) The spring recess athletic schedule would have to be scrapped.

There is a good reason to doubt that the plan would be of any particular benefit to the engineers and to the national defense effort. In response to a letter of inquiry sent out to several leading industries, the ENGINEER received replies which pointed out that the effort involved in rescheduling and the inherent disadvantages of revamping a student's program make the plan impractical. Then too, a green engineer isn't worth very much to a firm for several months. Two weeks would not make any particular differance to the employers.

The ENGINEER sees good reason for student protest. These are not times to view the Cornell contribution to National Defense with a sentimental eye; the concrete effects on the entire University are of of greater significance. A University is a place of study, a place where conditions should be adjusted so that studies receive the maximum attention possible. Elimination of a necessary vacation is not commensurate with the fundamentals of a good education. Add to this the other disadvantages of the plan, and the polite suggestion of the College of Agriculture becomes exactly what it started out as, a polite suggestion.

About Secretaries

DOWN in Room 50 in Baker Laboratory there are two people who are important to Cornell's chemical engineers, Dr. F. H. Rhodes and his "right hand", Mrs. Helen Robinson (formerly Miss Helen Terry). Mrs. Robinson, better known as "Helen" to the future occupants of Olin Hall, is as famous for her smile as she is for her efficiency. Indeed, her smile has long been a source of comment with "Dusty's" boys.

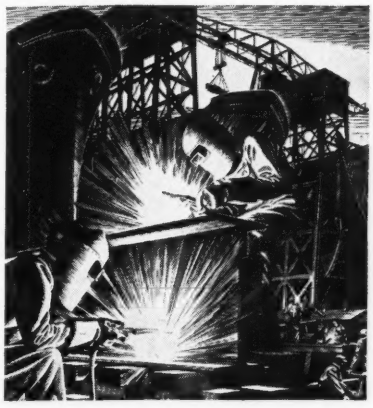
Her education took place in the same institution that Henry Morgenthau received his, the Ithaca High School. Following graduation in 1934, Helen had the good fortune to be made assistant to the personnel director of Rothschild's department store. In 1935 the desire to work at a higher altitude (and at a higher salary) brought Secretary Terry up to the top of the Hill, where she has since remained. Her first employer on the Hill was L. N. Simmons, attorney for the University. After working in Morrill Hall for three and a half years, she moved to Baker Laboratory (January 7, 1939). As to her job, Mrs. Robinson states, "I enjoy working for Dr. Rhodes."

Another Helen

The civil engineers also have a Helen in the School Director's office. Her name is Helen Flynn and she comes from nearby Waverly. Cornell is old stuff to her, for she passed through three years of the University's Arts course (class of '39). Finding the Arts curriculum a little aimless (the engineers' perpetual comment) Coed Flynn moved to Katherine Gibbs in Boston to learn something which would do her some good. Following graduation from what she describes as a "tough" course, she went to work in New York City as a secretary for an importing concern. With this experience as a background, she came to Cornell and went to work for Raymond Howes, the publicity man for the College of Engineering. When Mr. Howes moved over to Morrill Hall, Helen moved over to Lincoln. She has been there since August.

As a coed, Helen was a member of Delta Gamma sorority and the Freshman Advisory Committee.

The ramparts we build...



As OUR COUNTRY moves through perilous world events, national defense is uppermost in our minds. Is defense production fast enough? Is American industry turning out the goods? How are American engineers and production men meeting defense problems?

Here's how matters stand at Westinghouse:

We are engaged in building more than $300,000,000 worth of equipment for the national defense program. On our books are more than 3,600 defense orders. To meet schedules, we must produce $960,000 worth of apparatus every day—$40,000 every hour—between now and the end of 1941.

Every one of the Company's 26 manufacturing divisions is working on national defense projects; most of them on a three-shift basis.

Employment is at an all-time peak of 75,000, a gain of more than 25,000 since a year ago. One in three Westinghouse employees is new.

To avoid delays due to shortages in materials and to release metals needed for other defense projects, substitute materials committees have been organized in every Westinghouse plant to find ways to make use of new materials wherever possible. One result: our Merchandising Division alone has found ways to save 1,500,000 pounds of aluminum out of next year's manufacturing schedule. That's enough to build 130 Army bombers.

Many things we are making for the Navy, Army, and defense industries are military secrets, but we can mention:

Parts for control units on anti-aircraft guns.

Special land, sea, and air radio equipment for the Army and Navy.

High-speed X-ray equipment, capable of examining soldiers at the rate of one a minute.

Army binoculars.

Fluorescent lamps for "blackout" plants and others.

Secondary networks for defense plants. These are systems of power circuits and equipment so arranged that if one part of the factory is destroyed, current will continue to be available in all undamaged sections.

Some of the things we're making for air defense are:

Special meters and instruments for Army airplanes.

Lightweight generators and voltage regulators to supply and control electric power in Army planes.

Bomb fuses, now being turned out at a high rate. Production will be doubled again in a few weeks.

Plastic parts for aircraft, including Micarta pulleys and fair leads to guide the control wires inside planes.

Radio sending and receiving apparatus.

Lighting systems for airports and seadrome lights capable of converting open waterways into landing bases for seaplanes.

Now at work on propulsion equipment for more than 100 Navy ships is the Westinghouse Steam Division plant at South Philadelphia.

Driving gear for 80 merchant vessels also is being made at this plant.

Besides helping to build our first lines of defense Westinghouse is supplying power equipment urgently needed for the speed-up of its own and other defense industries.

Our East Pittsburgh Works this year will *double* its 1940 production of generating equipment.

The Generator Division completed this year the three largest water-wheel generators in the world—108,000 kilovolt-ampere giants for Grand Coulee.

The Motor Division will produce enough motors in 1941 to develop 2,660,000 horsepower; enough power to drive all the machinery in 50 steel mills. Majority of these motors will be driving machinery for defense.

This, in outline, is the way the Westinghouse Company and Westinghouse engineers are doing their share in national defense.

Westinghouse

Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.

Steam Power Plants

(*Continued from page* 13)

ash in the coal passes up through the unit and the load on the fly-ash recovery system is much reduced.

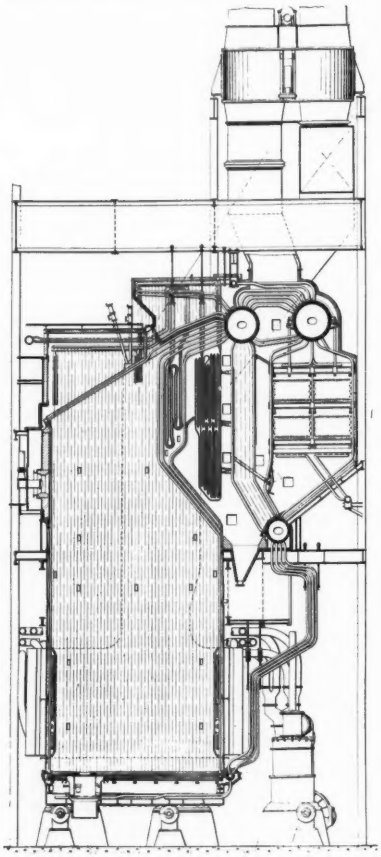
One would be rash, indeed, to attempt to predict what further improvements in steam plant practice the next decade will bring forth. The era of superimposing high-pressure equipment on old low-pressure plants in order to provide additional power and improve station economy—a practice very prevalent five years ago—is now on the wane as most of the older stations susceptible to such topping have become thus modernized. Present activity appears to be confined more to extensions to existing installations and the construction of new plants. Practice in new plant installations is about equally divided between high pressures of 1400 lb. and above and more moderate steam conditions of the order of 900 lb. and 900 deg. F. The latter, while sacrificing some slight thermal economy, offers some compensation in lower initial costs.

The binary cycle, employing a mercury boiler and turbine superimposed on the steam plant has passed through a long period of development, and three installations of moderate capacity are reported to be in successful operation. The station economy, however, is only slightly under that of the best plants operating on the high-pressure straight steam cycle, and the initial cost is likely to be considerably more. While it is possible that further opportunities will occur from time to time where the mercury-steam cycles will be warranted, there is no new construction in progress at present.

The pioneer installation of a large forced-circulation steam generating unit, the first to be installed in this country and exceeding in capacity and pressure any units abroad, is now nearing completion at the Somerset Station of the Montaup Electric Company in Massachusetts. Designed to operate at around 1800 lb. pressure and 960 deg. F. steam temperature this unit will have a capacity of 650,000 lb. of steam per hour. Its performance will be watched with keen interest by power plant designers.

Owing to the great diversity of local conditions and the constant urge to attain the ultimate in performance, power plant equipment defies standardization to any considerable degree, despite the fact that there is much that can be urged in its favor.

No radical changes in the generation of electric power are now in sight. The upper ranges of the steam cycle, in the realm of high pressures and high temperatures, have been explored and advantage taken of the economies offered. The major loss continues to be at the lower end of the cycle, namely, the heat lost to the condensing water, and no practical means have been evolved for utilizing this vast amount of low-head heat which amounts to the major portion of the heat in the fuel. Despite this, the overall efficiency of the most economical steam stations is on a par with that of the oil engine which still has capacity limitations.



Million-pound-per hour steam generating unit

Maximum thermal efficiencies for individual equipment are approaching the ultimate, although further refinements will narrow this margin and make possible further operating economies. A greater degree of standardization would tend to reduce initial investment and thus lower fixed charges, but this must be balanced against possible reduced thermal efficiency in the individual case.

Although further reduction in the average fuel consumption per net kilowatt-hour output is likely, it will be by smaller steps than those achieved during the last two decades. That is, while the present average for all utility plants is 1.35 lb, many of the modern stations are producing a kilowatt-hour on well under a pound of coal. As such stations predominate more and more in the overall picture with the retirement of less efficient plants, and as capacity use factors increase, the average coal consumption per kilowatt-hour should continue downward. The extent to which this will be possible under present emergency conditions, when there is a demand for all available power, is unpredictable.

The COLLEGE

(*Continued from page* 15)

son, both assistant professors of mechanics of engineering.

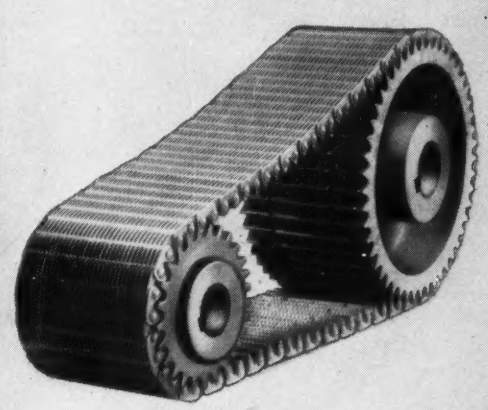
Assistant Professor Lee was graduated from the University of Pittsburgh in 1936, after which he came to the Cornell Graduate School and obtained his M.S. in Engineering in 1937. He was an instructor in mechanics of engineering until 1940 when he received his Ph.D. Last year he went to Carnegie Institute of Technology and this year returned to Cornell. He has published four pamphlets on photoelastic materials.

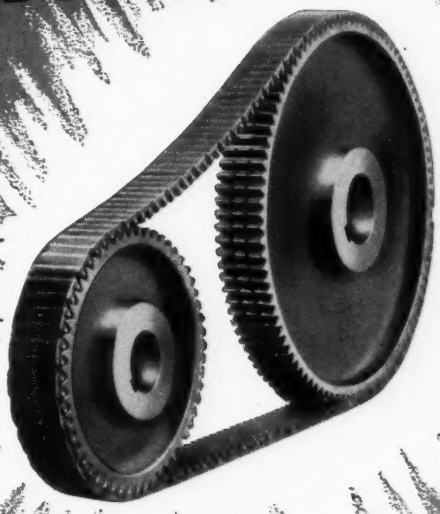
In the School of Civil Engineering, H. M. Gifft has been appointed assistant professor of mechanics and concrete structures. He was graduated from Iowa State College,receiving his degree of B.S. in Civil Engineering in 1932. He later received his Civil Engineering degree and M.S. in Civil Engineering there.

Instructors in the Sibley School of Mechanical Engineering include N. R. Bell, instructor of engineering

(*Continued on page* 30)

SAME R.P.M. . . . .





Compare the two drives shown above. They are drives for the same motor and machine, same horsepower, same speeds. The Morse high speed drive (right), although much narrower and lighter, has equal or greater capacity because of its higher chain speed . . . and it actually costs less than the old-type drive.

GREATER CAPACITY and Lower Cost

It's a revolutionary idea—and it works! To gain greater capacity for drives—with the same old motor r.p.m.—speed up the chain by using larger sprockets with more teeth. The impossible drive is now possible.

This is the principle of Morse engineered High Speed Drives and it is producing amazing results—greatly increased power transmitting capacity at lower costs.

High chain speeds, with Morse High Speed Drives, do not cause slip or power loss. The action of the chain on this drive utilizes centrifugal force to produce better contact with sprocket teeth, to even the load distribution, to reduce wear, to cut down bearing loads. Operation is unbelievably silent.

The cost of Morse engineered High Speed Drives is low—lower than other types of high speed drives!

Morse engineered High Speed Drives are applicable to speeds from 400 to 4000 r.p.m. Ask the Morse man in your territory, or write Morse, Ithaca.

MORSE *Engineered* **HIGH SPEED DRIVES**

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

The COLLEGE

(*Continued from page* 28)

drawing; Harold J. King, instructor of experimental engineering; W. L. Koch, instructor in aeronautical engineering; C. B. Mansky, instructor in mechanics of engineering; J. N. Mitchell, instructor in administrative engineering; and T. L. Whitesel, instructor in administrative engineering.

Appointments in the School of Electrical Engineering are A. B. Credle, instructor; and J. G. Hutton, instructor.

In the School of Civil Engineering, M. S. Priest has been appointed instructor.

McMullen Scholars

THIS is the list of men from the Class of 1945 who were awarded the John McMullen Regional Scholarships:

DISTRICT 1

Sidney Law, Springfield, Massachusetts; Frank T. Gerould, Longmeadow, Massachusetts; Harrison Parker, Winchester, Massachusetts; Girard S. Haviland, West Hartford, Connecticut; Laurence A. Lantz, Melrose, Massachusetts.

DISTRICT 2

Robert B. Benscoter, Kane, Pennsylvania; William R. Ebersol, Pittsburgh, Pennsylvania; Mitchell W. Beardsley, Narbeth, Pennsylvania; Ludwig P. Vollers, Drexel Hill, Pennsylvania; Parks Landis, Scranton, Pennsylvania; William A. Dunn, Duncansville, Pennsylvania.

DISTRICT 3

Wilbur O. Gundlach, Plainfield, New Jersey; Laurance A. Weber, East Orange, New Jersey; Charles M. Holmes, Orange, New Jersey; Robert P. Stebbins, Hackensack, New Jersey; William J. Rothfuss, Plainfield, New Jersey; Sutherland R. Simonds, Red Bank, New Jersey; Frederick L. Ludden, Dover, New Jersey; George E. Williams, Dover, New Jersey.

DISTRICT 4

Robert J. Millar, Washington, D. C.;Frank A. Swingle, Washington, D. C.; Frank M. Herring, Baltimore, Maryland; Joseph F. Davis, Pikesville, Maryland; Ferdinand B. Koch, Ruxton, Maryland.

DISTRICT 5

Robert W. Madden, Daytona Beach, Florida.

DISTRICT 6

Oscar T. Buffalow, Chattanooga, Tennesee.

DISTRICT 7

Richard L. Shaner, Youngstown, Ohio; James R. Whitman, Steubenville, Ohio; John E. Frech, Dayton, Ohio.

DISTRICT 8

Dorsey T. Mahin, West Lafayette, Indiana; J. Coleman White, La Porte, Indiana.

DISTRICT 9

John W. Hunt, Evanston, Illinois; Thaddeus Lasiewicz, Chicago, Illinois; William G. Harris, Hinsdale, Illinois; Wendell E. Veach, Rockford, Illinois; William A. Barr, Aurora, Illinois; William P. Barber, Barrington, Illinois.

DISTRICT 10

Claude W. Silas, Sherman, Tex.

DISTRICT 11

Robert E. Rath, Omaha, Nebraska; Daniel D. Mickey, Kansas City, Missouri; John J. Hanighen, Omaha, Nebraska; William T. Duboc, Kansas City, Missouri; Harry L. Hilleary, Webster Groves, Missouri.

DISTRICT 12

John K. Stotz, Beloit, Wisconsin; Philipp W. Binzel, Milwaukee, Wisconsin.

DISTRICT 13

Robert D. Whiting, Wheatland, Wyoming.

DISTRICT 14

Harold B. Myers, Keams Canyon, Arizona; Richard G. Milhan, Pueblo, Colorado.

DISTRICT 15

Ralph E. Schmidt, Yakima, Washington; Frederic F. Wiedemann, Hollywood, Cal.; Howard G. Turner, Deep Springs, California; James R. Olin, Deep Springs, California; Donald P. Haggart, Canal Zone.

ASME Meeting

WE VENTURE to say that never in the history of Sibley's room 2 has it had to support a crowd such as attended the meeting of the ASME on Tuesday night, October 7. The girders must have groaned and the foundations settled when about 250 persons filled the seats, stood near the walls or squatted on the floor as they witnessed a sound film on the "Airacobra" lent to the student branch by Bell Aircraft.

After the meeting refreshments were served, but they did not last long once the mob started eating.

The sound film showed the maneuverability of and several steps in the manufacture of the Airacobra at Bell's Buffalo plant. The salient features of its design, such as engine to rear of pilot, tricycle landing gear, and 37 mm. cannon mounted in propellor hub, were shown by numerous shots of the plane flying and firing. In addition to the 37 mm. cannon, the Airacobra has two .50 caliber machine guns which fire through the propellor blades and four .30 caliber machine guns mounted in the wings.

PROFESSOR CARRUTHERS

(*Continued from page* 16)

spare time to work out problems of design. He holds patents for bottle-capping machinery, a pump, and a liquid fuel burner, has a number of patents pending, and is at present working on a machine for the selective packing of canned tuna.

Professor Carruthers took his present position as professor of materials processing in 1940, when Professor Wells retired. Since then, he has been quite busy administering his department and directing the revision of its study plan. This has meant that little time remains to indulge his interests in music, art, model making, and furniture making. He has a wife and two children, Jimmy and Sally; it is Sally, aged seven, who on Saturday mornings "assists" Lamb in the machine shop tool-cage.

President's Message

(*Continued from page* 24)

search must be continued, and it ought to be possible that it be made a major function, perhaps disassociated to a large extent from the drone work of teaching.

There are teachers. Cornell has had some memorable examples. There must be more and the way to secure them must be found. Let's all work together to provide a basis which will supply to Cornell an outstanding, satisfied teaching staff. Let's not get the cart before the horse.

C. REEVE VANNEMAN

SWEEPING STEEL WITH A BROOM OF FLAME

SWEEPING over metal structures and structural parts this modern broom of fire prepares metal surfaces for a long-lasting, protective coat of paint. It is the Airco Flame Cleaning Process and removes rust and scale and dehydrates metal surfaces as it cleans. It provides a warm, dry surface conducive to a lasting paint job and assuring a faster one. Flame cleaning is the most effective method yet devised to prepare metal surfaces, new and old, for painting and repainting. Ultimate maintenance costs are lower.

Versatile is the oxyacetylene flame. It provides better and faster ways of making machines, engines, ships and tanks by shaping thin steel plates or heavy slab forgings and structures with economical ease and with a high degree of accuracy. The oxyacetylene flame hardens steel to any desired degree and depth. It softens steel, or bends it, or straightens it. It removes scale from billets, castings and forgings.

Possibly you are interested in learning more about the machines and apparatus which harness the Airco oxyacetylene flame and put it to work in so many different ways. If so, write for a copy of the pictorial review "Airco in the News" to the Airco Public Relations Department, Room 1656, 60 East 42nd Street, New York, N. Y.

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DISTRICT OFFICES IN PRINCIPAL CITIES

STRESS and STRAIN...

An Engineer is a man who knows a great deal about very little and who goes along knowing more and more about less and less until finally he knows practically everything about nothing.

A Salesman is a man who knows very little about a great deal and keeps knowing less and less about more and more until he knows practically nothing about everything.

A Manager starts out knowing practically everything about everything, but ends up knowing nothing about anything, due to his association with engineers and salesmen.

* * *

Said the skunk when the wind changed, "It all comes back to me now."

* * *

A man in the insane asylum sat fishing over a flower bed. A visitor approached, and wishing to be affable remarked, "How many have you caught?"

"You're the ninth," was the reply.

* * *

Then there was the EE who called his girl "Carbon" because her resistance went down when she warmed up.

* * *

When we took our girl home we tried to oscillate, and she almost had hysteresis, but we couldn't transformer. As we were walking up the sidewalk, a de-generate girl with brown coils threw ergs at us, so we called a copper to arrester. We didn't know it would a-vector that way.

—*Kansas Engineer*

* * *

Voice over phone: "How do you feel this morning?"

Lady: "All right."

Voice: "Then I guess I have the wrong number."

—*Nebraska Blueprint*

Freshman (at P.O.): "I'd like to see some of your two-cent stamps, please."

The clerk produced a sheet of a hundred twos.

The freshman pointed to the stamp in the center: "I'll take that one."

* * *

"I'm losing my punch," she said, as she left the cocktail party in a hurry.

* * *

Bill (as he caught up with Gus on the way back to camp): "Gus, are all the other boys out of the woods yet?"

Gus: "Yes."

Bill: "All six of them?"

Gus: "Yes, all six of them."

Bill: "And they are all safe?"

Gus: "Yes they are all safe."

Bill (chest swelling): "Then I've shot a deer!"

* * *

Mother: "Billy, what are you reading?"

Billy: "Film Fun, Mama."

Mother: "Oh, all right, dear, I was afraid you had gotten hold of The Cornell Widow."

* * *

One firefly flew excitedly up to another firefly in Hyde Park, London, and said:

"Put out that light! Douse it. Don't you know that this is a black-out?"

"How can I help it? When you gotta glow, you gotta glow!"

* * *

Guest in Hotel: "Manager, please send me up a full length mirror."

Maitre d'Hotel: "Why, there is a half length mirror in every room."

Guest: "That's just the trouble. Twice already, I've gone down to the dining room without my trousers."

"The man who marries my daughter will get a prize."

"May I see it, please?"

* * *

Jimmie giggled when the teacher read the story of a man who swam a river three times before breakfast.

"You do not doubt that a trained swimmer could do that, do you, Jimmie?"

"No, ma'am, but I wonder why he didn't make it four and get back to where his clothes were."

* * *

Then there was the Scotchman who saved all his toys for his second childhood.

* * *

Professor in Physics: "You don't understand the derivation? Well, watch the blackboard while I go through it."

—*Colorado Engineer*

* * *

Mother: After all, he's only a boy, and boys will sow their wild oats.

Father: Yes, but I wouldn't mind if he didn't mix so much rye with it.

* * *

Professor: "You should write your themes in such a way that even the most ignorant people can understand them."

Student: "Which one of them didn't you understand?"

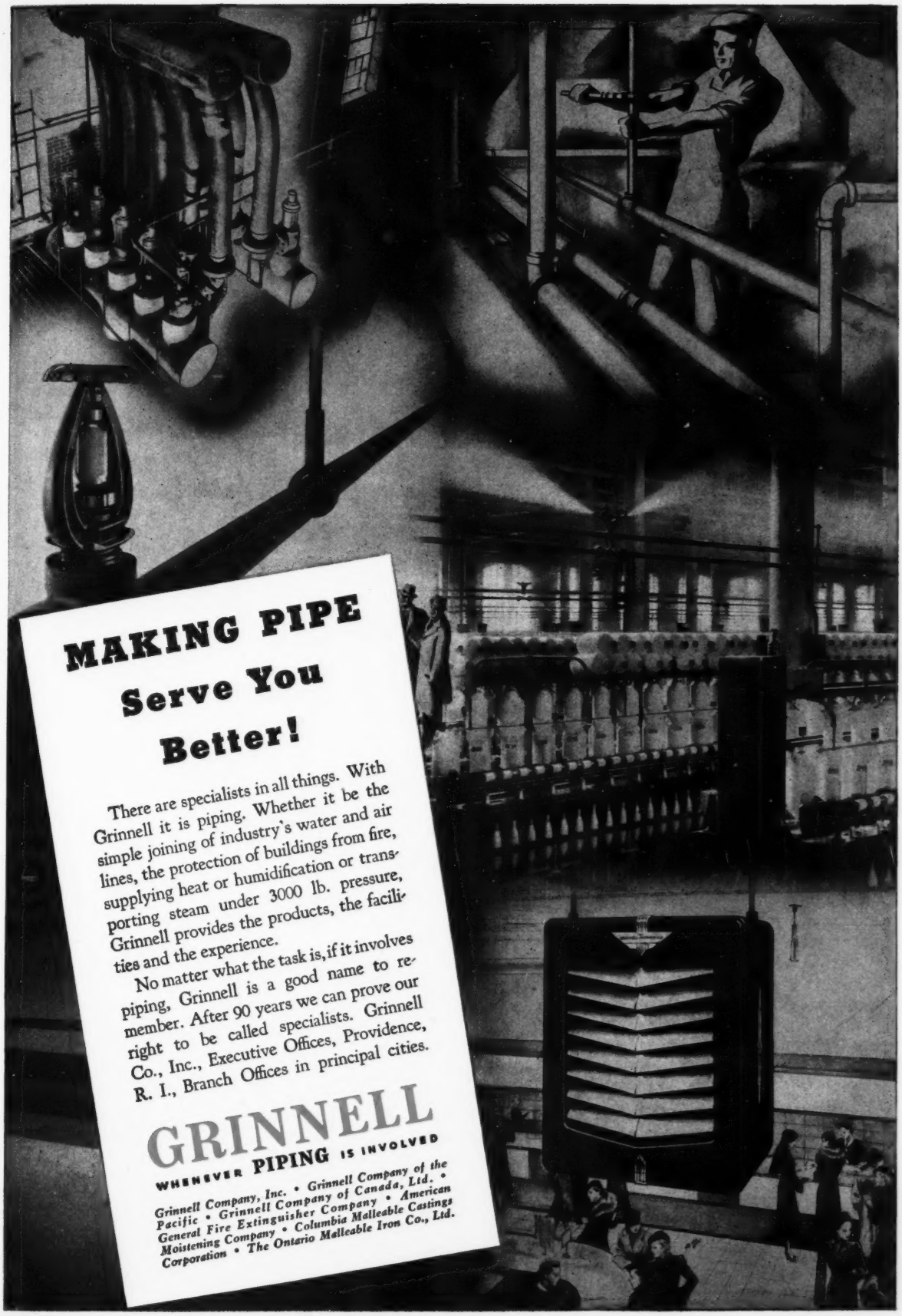
* * *

The other day a man looked in the obituary column and read that he had died. He immediately called up a friend and said, "Did you read that I died?"

The reply was, "Yes, where are you calling from?"

* * *

Breathes there a man with soul so dead
Who never to himself hath said,
"To hell with these studies, I'm going to bed."



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G-E Campus News

MOSQUITOES DON'T LIKE RED LIGHTS

OUT in Cleveland, Ohio, a group of engineers and entomologists has been spending a lot of warm summer evenings sitting around under a string of colored lights. But any passerby who got the impression that they had joined the rocking-chair brigade would be very much mistaken. They were conducting a scientific experiment to determine what color lights attract, and what repel, night-flying insects.

Results: mosquitoes and most other night-flying insects don't like red lights, prefer blue. But since red is not a very satisfactory color to work under, the scientists suggest that if you must work under a lamp outdoors, yellow light provides the maximum advantages to human beings with the minimum attraction to insects.

LEFT-HANDED BUCKETS

UNLIKE the famous fellow who wanted a left-hand monkey wrench, the young man at the window is perfectly in the right if the buckets he wants are the buckers for a steam turbine. For a double-flow turbine for ship propulsion has both right- and left-hand buckets.

There's an important reason for using this construction. Though it sounds more complicated, a double-flow turbine operates at higher speed, weighs less, and occupies less space than a single-flow one. All these are distinct advantages when the equipment has to be installed in a ship, where space is at a premium. And in times like these, when turbines must be turned out in a hurry, the smaller metal parts required represent an advantage in manufacture, too.

General Electric, which has probably built as many naval and marine turbines as any other single manufacturer, is right now making more of them than at any time in its history. And by taking advantage of every engineering and manufacturing advance, it is turning them out on what approaches a mass-production basis.

WANT A BOOKLET?

NOT required reading in any course we ever heard of. But if lightning should strike you some day, you'd be glad to know what hit you. This booklet explains the whys and wherefores of lightning. Tells you how to recognize lightning when you see it, how to catch it if you should want to take some home to play with, etc. In fact about the only thing missing is a "lightning" index to enable you to thumb to your favorite passage in less time than it takes to say "blitz."

And if you have just been on a textbook-buying binge, you may be interested in the fact that this 24-page pamphlet is free.

If you *are* interested, write to the General Electric Company, Dept. 124F, Schenectady, N. Y., and ask for "The Story of Lightning," based on the work of Dr. Karl B. McEachron author of the book, "Playing with Lightning."

GENERAL ELECTRIC

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